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ENVIRONMENTAL PROTECTION

TRIWA II
Management of an International River Basin District – Torne River

Luokkanen Eira, Olofsson Patrik, Hokka Ville and Sundström Bo (eds.)

Lapland Regional Environment Centre,
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PREFACE

Lapland Regional Environment Centre and County Administrative Board of Norrbotten have been deepening cooperation in water related issues since 1980´s. This work realized in a project in the 1990's for describing the status and loading of the common river system, Torne River. This work continued in a multiple project run in 2003-2006 under TRIWA umbrella (TRIWA, Torne River International Watershed), where common typologies for the lakes and rivers in this area were formed, together with a suggestion for a joint monitoring programme.

This report presents results of the TRIWA II project run in 2006-2008. The project was partly financed by the EU Regional Development Fund, INTERREG IIIA Nord. The partners in the project were

Lapland Regional Environment Centre (LAPREC)
County Administrative Board of Norrbotten (CAN)
Finnish Environment Institute (SYKE)
Finnish Game and Fisheries Research Institute (FGFRI)
Swedish Board of Fisheries (FiV)

Numerous people have been involved in this project. The authors would like to thank you the steering group members Matti Hepola and Pekka Räinä (LAPREC), Ulf Bergelin (CAN), Peter Hagström (Council of Torne Valley), Antti Lehtinen (SYKE), Jerker Marklund (Finnish-Swedish Frontier Rivers Commission), Kerstin Rosén-Nilsson (Swedish EPA), Stefan Stridsman (FiV), Teppo Vehanen (FGFRI) for all their contribution during the process, and stimulating discussions during the meetings. Petri Liljaniemi and Paula Alho (LAPREC), Sara Elfvendahl, Lisa Lundstedt (CAN) were contributing to the planning of the project and/or various parts of the work. Special thanks to Anni Korteniemi for summer 2007, Johanna Alm from Vattensamverkan Norr, and Tiina Käki. We would also like to thank you the laboratory of LAPREC for good cooperation. All you working in the field in both Finland and Sweden deserve a special thank you! And finally, Hannu Lehtomaa, Liisa Viitala and Sari Björkbacka, thank you for your efforts with this report.

Rovaniemi and Luleå, February 2008

The authors

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INTRODUCTION

The river basin of the River Torne covers 40 157 km^2 of which 25 393 km^2 are in Sweden and 14 480 km^2 in Finland, and some 284 km^2 in Norway. The River Torne is one of the last free running rivers in Europe and it is a Natura 2000 site in both Sweden and Finland. The river chain Könkämä-Muonio-Torne was set as a boundary in 1809, first between Sweden and Russia, and since 1917 between Sweden and Finland. Historically, the river has been more unifying people than separating them, being an important transportation channel for people and goods as well as source for living in form of water and fish. Strikingly, locally the major channel is called Väylä – the Route. Today transportation has moved to wheels, rails and wings, but Väylä is still vital for the region as source for both livelihood and recreation.

The sustainable use of the resources in the region is of vital importance for social and economic development of the region. As actions in the whole river basin affect the state of the river, for example, better understanding of the current conditions as well as mutual understanding of the measures for managing the river basin is needed. In order to gain this, cooperation needs to be strengthened at different levels, including regional involvement and interaction between local people, actors and authorities.

Managing a river basin includes a wide concept of actions and methods for assessing the state of waters, evaluating the different elements affecting it, forming the goals for the future and planning actions needed for gaining the goals. In the Torne River area there has been cooperation around these questions (see for example Puro-Tahvanainen *et al.* 2001, Elfvendahl & Liljaniemi 2006) and need for developing and deepening this cooperation has been recognized, but wider concept has been lacking. The Water Framework Directive of the European Union (WFD) has set demands for assessing the state of our waters as well as for managing them. WFD expects cooperation between the states governing the same river basin district. However, the level of cooperation is not accurately defined. There are also other related directives implemented, and the way of implementation can differ from state to state. In addition, other national legislation and procedures cause differences. Forming an overall picture of the most relevant questions is of importance in order to be able to deepen and facilitate the cooperation.

TRIWA II project

The project 'Best practices for the management of an international river basin district – Torne River' started in May 2006. The total budget of the project was approximately 300 000 euros, 60 % of which is covered by INTERREG III A North funding, the rest being split between Finnish and Swedish national funding.

The project is a continuum for the prior TRIWA project, where suggestion for typology and monitoring programme for the area were drafted. In this project, work was directed more towards actual management. The target has been to increase cooperation and exchange of information between authorities and other actors in the region by building a suggestion for a management procedure for an international river basin district. The aim has also been to increase knowledge of natural conditions of the northern environment in order to improve the possibilities to react to the changes in the environment. Lack of basic knowledge in this vast, complex area is apparent.

The project was realized with different subtasks. This report represents results for management issues in part I: comparisons of legislation and administrative processes, considerations of the most relevant agreements and conventions, and discussion on participatory processes. Part II includes studies on ecological indicators in two separate parts, i.e. fish studies for small lakes and phytobenthos studies for rivers. They both include testing of a common typology suggested for the Torne River area. In addition, the suggested Finnish and Swedish classification systems are tested (according the available information during the work), and their usability in the evaluation of the ecological status of water basins in the region is evaluated. Finally, in part III, conclusions are drawn with core suggestions and recommendations for the future work, including a simplified co operational structure and timetable for the common water management work.

Part I

Management methods and coordination of actors and organs

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Eira Luokkanen

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1. Introduction

Sustainability has over the last years developed to become an overriding political goal in industrialized western societies as Finland and Sweden. Increasing evidence of environmental malfunctioning and ecological problems (as for instance climate change) have shown that there is a strong need for generally improved human socio-economic adaptation to ecosystem limits and functioning. On the political arena, the changing values are shown by many initiatives, as for instance the Water Framework Directive of the European Union (WFD), which was adopted in the year 2000.

Water has a central and "strategic" role in natural and socio-economic ecosystems (agricultural, urban-industrial, etc.) through its biological functions as well as transport medium and integrative connecting network. Clean water – water of a certain quality – is therefore a crucial resource for the functioning of nature and human welfare in our societies. The aim of the WFD is to improve and safeguard the quality of water in the EU countries by creating a new and systematic administrative management and planning system for all water resources.

Improving human adaptation means in practice changing many small and big things in how we all live – produce, consume, travel, etc. In order to do that we must first and foremost understand and become aware of how we actually manage and control social evolution and change – to the extent this is possible – or in other words how the management and planning of our society works in practice. Laws and regulations decided in the political systems on international and national levels are the foundations of planning and management. However, the actual use and application of these laws in the institutions (and in a social context – relations with other actors and organs), and the administrative processes that are formed over time are also very important when discussing for instance how a new water management and planning system should work.

2. Legislation and agreements

2.1

International agreements

International agreements are highly relevant for defining the foundations behind practical river basin planning solutions in an international River Basin District. The Water Framework Directive (WFD) recognizes and enforces international agreements in several articles and subsections. The directive identifies directly e.g. the Convention on the Protection of the Marine Environment of the Baltic Sea Area, signed in Helsinki on 9 April 1992, and the United Nations Convention on the protection and use of transboundary watercourses and international lakes.
Implicitly WFD recognizes also other agreements, such as the Convention on Biological Diversity (CBD) that is implemented in the Member States ultimately via legally binding Natura 2000 network. As specified in the WFD, the relevant Natura 2000 areas are to be included into the register of protected areas and managed according to the relevant directives that are i.e. Habitat Directive 92/43/EEC and Birds Directive 79/409/EEC (WFD Article 4 and Annex IV).

In Finland, inventories of international agreements and conventions have been compiled for Lapland Regional Environment Centre already in 1999 as a preparatory task for altering the Frontier Rivers Agreement between Finland and Sweden (1971) (as referred by e.g. Hepola 1999). In this summary, the international agreements and implementation strategies considered relevant in reference to the Water Framework Directive implementation initiated in 2000 are presented briefly. In relation to the agreements, some water management issues are highlighted for the competent authorities to address.

The most relevant agreements concerning the Torne River Basin District in relation to river basin planning are summarized below. Here, only parts of the contents are listed with focus in management planning. The Frontier Rivers Agreement between Finland and Sweden (1971) is handled in a separate section (4.1). Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (1995) has been omitted, though it also has links to the work. It is foreseen that salmon fishing affecting River Torne is connected to the European Union marine policies, whose implementation is currently under formulation. The agreements reviewed, together with their national implementation strategies and instruments, include:

- Convention on the Protection and Use of Transboundary Watercourses and International Lakes (1992)
- The Convention on Biological Diversity (1992)
- Helsinki Convention (1992)
- Espoo Convention on Environmental Impact Assessment (1991)

Convention on the Protection and Use of Transboundary Watercourses and International Lakes (1992)

One of the conventions that are implemented in Finland through the national legislation for WFD is the UN Convention on the Protection and Use of Transboundary Watercourses and International Lakes (1992) (UN 1994). Thus, issues handled here are at least partly identical to those in WFD. The Convention is composed of three parts, Part I concerning all parties, Part II for riparian parties or parties forming joint cooperation and Part III specifying institutional and final provisions i.e. mainly administrative issues of the convention. Of the annexure, points of interest are the general definitions of best available technology (annex I), guidelines for developing best environmental practices (annex II) and guidelines for developing water-quality objectives and criteria (annex III).

More generally, WFD would provide concrete structures for the convention meaning that WFD partly implements this convention in practice. In Torne RBD, the Frontier Rivers Agreement and the Frontier Rivers Commission *per se* act as concrete platforms and means of the implementation of the convention. After signing the convention, also the Protocol on Water and Health (London, June 1999) and the Protocol on Civil Liability (Kiev, May 2003) have been adopted under the convention.

The Convention on the Protection and Use of Transboundary Watercourses and International Lakes requires that the parties shall prevent, control and reduce pollution of waters causing or likely to cause transboundary impact; ensure that transboundary waters are used with the aim of ecologically sound and rational water management, conservation of water resources and environmental protection; ensure that transboundary waters are used in a reasonable and equitable way; ensure conservation and, where necessary, restoration of ecosystems. It includes that measures for the prevention, control and reduction of water pollution are taken at source. The principles to be followed are the precautionary principle, the polluter-pays principle and the principle of sustainable use of resources, though during the time the last term was not yet used.

The precautionary principle is to be included 'by virtue of which action to avoid the potential transboundary impact of the release of hazardous substances shall not be postponed on the ground that scientific research has not fully proved a causal link between those substances, on the one hand, and the potential transboundary impact, on the other hand.

Parties have also committed to measures, licenses, application of technical solutions and emission discharge limits against pollution (Article 3). This includes using low- and non-waste technology, prior licensing of point source discharges (including monitoring and controlling them), using BAT-principle for discharges of hazardous substances in limits for waste-water discharges, stricter requirements or even prohibition imposed when needed and the minimum demand of applying biological treatment or equivalent for municipal waste water. Further it includes implementing measures to reduce nutrient load from industrial and municipal sources (for example using BAT), as well as developing and implementing best environmental practices (BEP) in order to reduce load of nutrients and hazardous substances from diffuse sources, with special reference to agriculture. Finally, this part includes applying environmental impact assessment and other assessment means, promoting sustainable water-resources management including the ecosystems approach, developing contingency planning, taking specific measures to prevent the pollution of groundwater and minimizing the risk of accidental pollution is minimized.

The convention includes also implementation of monitoring programmes, engagement into research and development, and information exchange for all parties of the convention. It also holds in forming joint bodies between the transboundary parties. Their tasks would cover implementation of the agreement including acting as an expert body, serving as a forum for information exchange and participating in environmental impact assessments.

Separately for riparian parties, the convention includes commitments for organizing joint monitoring and assessment as well as research, exchange of information, joint warning systems, mutual assistance and public information. It is worth noting that the public information specified here includes water quality objectives, permits issued and the conditions required to be met, results of water and effluent sampling carried out for the purposes of monitoring and assessment, as well as results of checking compliance with the water quality objectives or the permit conditions.

It can be said that the convention covers basically all the aspects of modern environmental permit procedure and views of sustainable use of the (water) resources, or vice versa. As a major rule, these principles are included in current environmental legislation some form in both Finland and Sweden (for example Finnish Environmental Protection Act and Decree, Finnish Water Act, and Swedish Environmental Code). Some aspects exist already in the current Frontier Rivers Agreement, and the new agreement will be a step forward in the implementation process.

<u>Water management issues to be addressed:</u> Ecological classification, environmental objectives and information sharing

The Convention requires that transboundary waters be used with the aim of ecologically sound and rational water management, conservation of water resources and environmental protection.

Have the differences between Finnish and Swedish ecological quality elements (ecological classification systems) been assessed so that similar impacts into waters are understood in a similar manner in both sides of the border? In case there are notable differences between ecological classification systems (e.g. in the *nationally preferred* quality elements, parameters or in limit values), there is a danger that similar impact is classified differently depending on the side of the border. Such is currently the case with fish index in lakes, while with diatom in running water assessments such a situation is not so likely to occur. It is therefore recommended, that careful assessments are made on which indices are used when discussing water quality at this stage of the implementation.

As a principle, receiving information concerning all ecologically harmful impacts identified on the Swedish side is important on the Finnish side and vice versa. It is therefore recommended that all ecological limit values used currently in the assessments be shared between the competent authorities. For instance, the values included in environmental permits in Torne could be shared or investigated further in case the currently available information on permit limit values is insufficient.

One open question is whether there is a need for identifying *all the ecological quality elements* that differ between the national systems and how to “translate” these into commonly shared terms in water management. One possibility is that the differences in classification systems are used in specifying the acceptable variation ranges of different ecological quality elements within Torne. The limit values of chlorophyll a in the presence of algal blooms, for instance, could be compared between Finland and Sweden. Possible differences, then, could be used in setting the accepted range and the more stringent value could be used as a limit for notifying the authorities on the other side of the border of possible presence of algal blooms.

For incorporating the precautionary principle, values outside the ecological limits should be excluded in the defined range of acceptance. As a rule of thumb, it is recommended that a percentage figure be defined between the Torne competent authorities for setting the acceptable deviation from ecological limit values or ranges. Application of such a percentage in practice by investigating different ecological quality elements would be the second step towards harmonization.

There might be an increasing need for “translating” wastewater discharge limits and environment permit limits into shared understanding and practice. In case the limits on the Swedish side were more stringent, similar limits could be applied in Finland and vice versa.

It is recommended that in restoration of ecosystems and watercourses, objectives be shared on each side of the border. Of the different water dependent species in Torne catchment, the river pearl mussel is one focus of management (see also Convention on the Biologial Diversity).

Protocol on Water and Health (1999)

The UNECE Protocol on Water and Health to the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes covers all waters (UNECE 2000). The purpose of the protocol is to prevent water related diseases and set requirements for adequate drinking water supply, sanitation etc. Principles and approaches of the protocol include for example precautionary principle, polluter-pays principle, sustainable consumption, integrated water resources management and equitable access to water.

The protocol specifies for example requirements for quality standards in drinking water, occurrence of discharges of untreated wastewater and storm water overflows from wastewater systems, wastewater collection and dates of implementation of the protocol, including requirement for public participation. Commitment to collecting data and water sampling are stipulated as well as to establishing warning system. Further, it makes provisions for increasing public awareness, enforcing education and research and development. It includes also declaration that public receives information on targets and target achievement dates freely.

A need to develop indicators designed to show how far the progress has contributed towards preventing, controlling or reducing water-related disease has been specified. Setting national and/or local targets for the performance that needs to be achieved or maintained for a high level of protection against water related disease is required with provisions for public participation. However, there is a specification not needing to apply all precautions where circumstances make them irrelevant.

In Finland, the demands of the convention are widely in use in for example in drinking water, household water and wastewater issues, including obligations for wastewater treatment plans. Implementation has been made for example by Environmental Protection Act and Decree etc. These are not handled here in detail.

<u>Water management issue to be addressed</u>: Objectives and monitoring of bathing waters

WFD register of protected areas includes bathing waters whose monitoring and administrative responsibilities are defined in Finnish administration quite specifically. The parameters, limit values and methods used in Finland differ somewhat from those in use in Sweden, which may influence monitoring programme and specific water quality criteria of WFD. It is also necessary to engage into administrative cooperation between municipalities and competent authorities in order to include the existing monitoring and water quality criteria of bathing waters into WFD implementation.

In Finland one form of implementing the convention in relation to WFD is the regulation of bathing water quality as specified in the Ministry of Social Affairs and Health Decision on the Water Quality and Monitoring Requirements (SosTMp 292/1996) for physical, chemical and microbiological quality elements and a further decision 41/1999 for microbiological quality elements**.** The first decision is applied also to the minor official bathing places, as the ones reported to EU have at lest 100 visitors per day. In these decisions, the health care officers of municipalities are defined as the competent authorities inspecting and monitoring the water quality of bathing waters and publishing the results.

In Sweden EU category includes bathing places with a minimum of 75–100 daily visitors on days when normally bathing takes place, "a nice summer day". The bathing season in the County of Norrbotten reaches between the 15/7 and the 15/8. In addition, the water quality criteria and the monitoring methods are defined in the decision.

Municipalities had identified roughly 400 bathing waters in Finland (in 2003) and approximately 850 in Sweden (in 2007). In WFD implementation, these bathing waters fall under the register of protected areas (WFD Annex VI, i.e. the register shall consist also of bodies of water designated as recreational waters, including areas designated as bathing waters under Directive 76/160/EEC).

The Finnish ministerial decision on bathing water quality criteria is shown in tables 1 and 2, and the Swedish Environmental Protection Agency's definition of the water quality criteria and monitoring methods in the table 3.

In terms of WFD environmental objectives of protected areas, the most stringent water quality objectives are to be adopted. However, also the specific directives defining the water bodies included in the protected areas need to be followed. In Sweden, separately defined guidance values and higher maximum values are used, guidance values and Finnish values being same or in the same category. Values used for EU category are the same, but for the Finnish bathing places also stricter national values are used. Today, there are merely two bathing places on Finnish side of the Torne River Basin, and none on the Swedish side falling under the EU category, thus further harmonization is not necessarily a task of high priority. There are numerous minor, controlled bathing places in the region, that fall off the EU category and whether further comparing and harmonizing due to them is needed could be an issue later on. This needs to be discussed and resolved by the competent authorities.

Table 1. The criteria of the Finnish ministerial decision (292/1996) for bathing waters.

1) Microbiological quality criteria for bathing waters	
Escherichia coli (44 °C, 24 h)	< 500/100 ml
Faecal streptococci (37 °C, 48 h):	< 200/100 ml
Enterovirus (1):	0 PFU/10 l
Bacteriofages /100 ml (1)	: none allowed
Salmonella (2):	less than 1 in 1 litre
2) Physico-chemical parameters	
pH(3):	6 – 9.
Oxygen saturation (%)(4):	80 – 120
3) Observations	
No detectable change in water colour	
No detectable change in secchi depth	
No detectable oil film or smell.	
No detectable foaming i.e. signs of possible reactive subjects (5).	
No detectable phenol odour.	
No floating substances (tar, plastic, wood, glass etc.).	
No detectable cyanobacteria bloom.	

(1) Enterovirus and bacteriofages are determined if either E. coli or faecal streptococci limit values are exceeded at least three times in two succeeding monitoring events.
(2) Salmonella is determined if it is suspected that waste water containing salmonella has entered the bathing water.
(3) In case pH is lower than 6 from other reasons than soil properties, the lowest accepted pH limit are 5.
(4) Oxygen saturation is measured if pH varies more than 1 unit between monitoring events or if visible signs of eutrophication are noticed.
(5) Reactive subjects are determined chemically in case the constant, long term foaming is observed in the bathing water.

Table 2. The criteria in the Finnish statute 41/1999 for microbiological parameters for bathing waters under EU category.

Microbiological parameter:	**Criteria**
Coliform bacteria (35 – 37°C, 24 h)	below 10 000/100 ml
Fecal coliform bacteria (44,5°C, 24 h)	below 500/100 ml
Fecal streptocochistreptococci (37°C, 48 h)	below 200/100 ml
Enterovirus (1)	0 PFU/10 l
Bacteriofages/100 ml	–
Salmonella(2)	0/1 l

Table 3. The Swedish criteria for bathing waters under EU category.

Sweden	**Guidance criteria**	**Maximum or minimum allowed criteria**	**Analysis and control method** (1)
Microbiological parameters			
Total numbers of coliform bacteria	<=500/100 ml	<=10 000/100 ml	Cultivation in tubes. Cultivation of the positive tubes on a substrate for confirmation.
Numbers of fecal coliform bacteria or E. coli	< 100/100 ml	< 1000/100 ml	Calculation according to MPN (Most Probable Number). An alternative is membrane filtering and cultivation on a suitable substrate.
Number of fecal streptococci (2)	< 100/100 ml	< 300/100 ml	The Litsky method. Calculation according to MPN. An alternative is membrane filtering and cultivation on a suitable substrate.
Salmonella		0/litre	Concentration through membrane filtering. Grafting on a standard substrate. Concentration – cultivation on isolation agar – identification.
Enterovirus		0 PFU/10 litre	Concentration through filtering, flocking or centrifugation and confirmation.
Physico-chemical parameters			
Secchi depth	2 meter.	At least 1 meter.	Secchi disc or visual control. In humic lakes a less strict secchi depth can be allowed.
Algae		No heavy bloom.	Visual control.
Colour	No abnormal change in colour.		Visual control.
Oil, tar and other foreign material, for example, wood, glass or plastic	None.		Visual control.
Mineral oils	No visual occurrence on the surface and no smell. (<=0,3mg/l)		Visual control. (If detected extraction of suitable volume and weighing of the dry substance.
Surface active substances	No lasting foam.		If detected, absorbance spectro-photoskopymetry with methyl blue.
Phenol	No smell. (<=0,0005mg/l)	(0,005mg/l)	Control of absence of smell from phenol. (If detected absorbance spectrophotoskopymetry (4-AAP))
pH	6-9		Electrometric with calibration at pH 7 and 9.
Oxygen saturation	80-120 %		The Winkler method or electrometric method.

(1) As an alternative to these analysis and control methods Swedish or European standard methods can be used.

(2) Analysis of fecal streptococci is only obligatory in marine waters, at bathing places close to waste water treatment plants with chemical flocking and in areas affected by cellulose, textile or food industries.

The Convention on Biological Diversity (1992)

The Convention on Biological Diversity (CBD) is based on the objective recognized in the International Convention on Biological Diversity (Rio de Janeiro 1992) of conserving the diversity of ecosystems, plant and animal species (natural organisms) and their gene stocks, and to promote the sustainable use of natural resources and the fair and equitable sharing of the benefits arising from the utilization of biological resources (UNEP 2007).

In Finland, the CBD is implemented nationally through the National Action Plan for Biodiversity in Finland, 1997–2005 (Kangas *et al*. 1997), which is overseen by a monitoring group consisting of representatives of various administrative sectors and other stakeholder organisations. The first progress report was prepared by the monitoring group in 2000 describing the implementation of altogether 124 measures within the action plan over the period 1997–1999. Based on these results, the monitoring group defined 12 important areas for development, and set short-term goals. Progress during the next phase of the action plan was assessed in the second report of the monitoring group, which was submitted to the Secretary General of the CBD on 12.11.2002. Third progress report, published in 2005 and evaluated in 2006 describes progress with the action plan and its associated development areas over the period 2002–2004.

In Sweden, the CBD was accepted in 1993. It is implemented through the Swedish Environmental Code, the national environmental goals and the Swedish government's letter from 2002.

The Swedish parliament has decided to integrate its biodiversity strategies and action plans into the framework of the 16 environmental quality objectives, which were adopted in 1999 and revised most lately in 2005. The national report that was written in 2005 gives an overview of how the content of the 16 objectives corresponds to the articles and work programmes of the CBD. One main finding was that the Swedish environmental quality objectives cover most of the national aspects of the CBD, while the international aspects and obligations are treated in other, more specific policy documents.

In National Action Plan for Biodiversity in Finland (Kangas *et al*. 1997), water is defined as the third main habitat of threatened species (main habitat for 9 % of threatened species). The general factors and activities causing threats for water related biodiversity have been connected to 1) eutrophication and water pollution, 2) disappearance and eutrophication of waterfowl habitats and 3) use and alteration of shorelines as follows. It needs to be noticed, that the action plan recognizes specifically salmon populations in Torne and Muonio Rivers to be threatened by diseases and over-fishing.

The most recent recommendations for Finnish Protected Areas Management (Leikola *et al.* 2006) proposed application of ecosystem approach for sustaining and enhancing ecological networks. In addition, a need for improved site planning was recommended by defining strategic targets and milestones, since the site planning had fallen behind national schedule. Harmonized nature conservation planning and water management concerning the Natura 2000 areas included in the register of protected areas of WFD (see also Chapter 2.3) are also linked to the implementation of the CBD.

Water management issues to be addressed: Strategic targets and potential ecosystem approach

In Torne, it is recommended that
1) aquatic habitats of Natura 2000 (esp. main habitat *Fennoscandian natural rivers*) are protected as integral part and *prioritized objectives* in the river basin,
2) migration and breeding of salmonids and the pearl mussel are acknowledged in the environmental objectives of WFD together with other aquatic Natura 2000 values (see below) and
3) the conservation of pearl mussel and salmonids (linked together as salmonids act as the breeding vector for the mussel) is considered a possible joint ecosystem approach effort in the Swedish and Finnish catchment.

As a separate issue, it is generally recommended that more field investigations be directed towards protected aquatic species and habitats.

In the summer 2007, a Finnish-Swedish project regarding investigation of river pearl mussel took place in the Torne river catchment area. This resulted in one new finding of the mussel. Together with earlier knowledge, the river pearl mussel is now known to exist in three different waters within the area, one in Sweden and two in Finland. This research project, together with its possible continuity, might be added into the programme of measures of River Torne river basin management plan.

In specific reference to salmon, because of the threats noticed in its protection in Torne in the National Action Plan for Biodiversity in Finland (diseases, over-fishing) and in relation to the Frontier Rivers Agreement draft mentioning the protection of salmon in the river area of Torne, one option is formulation of separate salmon conservation and management strategy. The strategy should have specific reference to preventing disease, fishing management and ensuring salmon conservation in river Torne.

Helsinki Convention (1992)

Helsinki Convention (1992 with amendments 2004) concerns the Baltic Sea and the convention specifies both principles (such as polluter pays and the precautionary principle) and measures against pollution (HELCOM 2004). The convention states that permits and monitoring are required for point sources of Baltic Sea. Contracting parties need to comply with Environmental Impact Assessments (EIA) and notify Helsinki Commission on impact assessments revealing adverse impacts to the environment. In the convention, harmful substances are specified for banning and reduced usage (Annex I). The convention regulates also ship traffic and offshore activities.

Criteria and legislative prerequisites concerning the prevention of pollution from land-based sources are specified in annex III, so that wastewater management is required from industries and municipalities, and agricultural loading needs to be monitored. Limit values of harmful substances need to be stated in environmental permits. References are provided for plant nutrient reduction practises from agriculture in relation to wastewaters and nutrient sources by animal densities, application and storage of manure and nutrients and winter crop cultivation. The annex specifies also water protection measures and nutrient reduction areas as follows:

a) Surface water
Buffer zones, riparian zones or sedimentation ponds should be established, if necessary.
b) Ground water
Ground water protection zones should be established if necessary. Appropriate measures such as reduced fertilization rates, zones where manure spreading is prohibited and permanent grassland areas should be established.

c) Nutrient reduction areas
   Wetland areas should be retained and where possible restored, to be able to reduce plant nutrient losses and to retain biological diversity.

Helsinki Convention also specifies that environmental permits and monitoring are assigned and made available for public. Similarly, the water quality objectives need to be made public. WFD implementation offers a framework for organizing these objectives.

> Water management issue to be addresses: Harmful substances, buffer zones and WFD objectives
>
> The relation of harmful substances within Helsinki Convention to the priority substances of WFD needs to be investigated in River Torne. A simple approach is the inclusion of the harmful substances of Helsinki Convention into the priority substances of WFD.
>
> The need for buffer zones, riparian zones, permanent areas with grass cover and retaining wetlands may require agricultural advisory planning in River Torne. In Finland it is now foreseen, that partial grass cover in the most sloped agricultural fields along watercourses is to be enforced via environmental subsidies for farming. Another practise to consider is preparation of buffer zone plans, which the farmers can implement on voluntary basis. For example, the competent authority could prepare these plans by using spatial planning tools in identifying suitable locations of such areas. Utilization of the synergies of spatial planning in water management has been initiated in Finland with recent proposals for e.g. applying existing plan symbol MY (land used in agriculture or forestry with specific environmental values) in municipal planning for establishing wetlands or buffer zones. Landscape assessment belonging to spatial planning may be used in identifying such areas. Another approach is the identification of sloped agricultural areas along watercourses as material for joint planning of water managers and spatial planners, which has been recommended in Finland. In general, collaborative planning between water managers and spatial planners in River Torne is suggested for further consideration of utilizing municipal spatial planning for water management purposes.
>
> In the lines of Helsinki Convention, the water quality objectives of Water Framework Directive for the Baltic Sea need to be made public. It is recommended that public participation events be utilized for these purposes. Therefore, once the common understanding of the joint quality criteria in River Torne has been achieved, it is proposed that these are presented in public participation with documentation. The results achieved in TRIWA II are considered suitable for such work. In the light of Helsinki Convention, it may become necessary to compare also the water quality objectives of the sea areas in the river mouth to a certain degree. In relation to monitoring and environmental permits, the water monitoring and permit procedures in Finnish and Swedish side of the catchment are to be explained.

Espoo Convention on Environmental Impact Assessment (1991)

The Espoo Convention requires and describes the process of Environmental Impact Assessment in a transboundary context from specified activities, documentation and general criteria for defining environmental significance to consultations of affected parties (UNECE 1991). In brief, the convention aims to prevent, reduce and control transboundary impacts and mediate the consultation concerning potential impacts between parties influenced by the proposed activity.

Of the specified activities, three are connected closely with water:

9. Trading ports and also inland waterways and ports for inland-waterway traffic which permit the passage of vessels of over 1,350 tonnes.
11. Large dams and reservoirs.
12. Groundwater abstraction activities in cases where the annual volume of water to be abstracted amounts to 10 million cubic metres or more.

Two of the activities are associated with land use:

14. Major mining, on-site extraction and processing of metal ores or coal.
17. Deforestation of large areas.

The convention, together with a relevant EU directive (85/337/EEC) has been implemented by national legislation both in Finland and in Sweden. In Finland there is a specific Environmental Impact Assessment Act (458/1994, latest renovations in 2006) together with a relevant Decree (713/2006).

In most cases, the authority guiding and evaluating the process is the Regional Environment Centre, with some exceptions. In actions having international effects, the responsible authority is The Environment Ministry. In Sweden the major rules are included in Swedish Environmental Code (SEC). The County Administrative Board decides if a full or a more restricted EIA process should be conducted. In both states, it is the duty of the developer to assess the environmental impacts of the project and its alternatives. The developer prepares the assessment documentation report on the basis of the investigations carried out. The municipality, concerned governmental agencies, organisations (NGOs) as well as the public are consulted in an auditing process. In Sweden, there are suggestions for simplifying the process.

EU Directive closely linked with the EIA process is that of Strategic Environmental Assessment, SEA Directive. In 2006, a separate Act on the Assessment of the Impacts of the Authorities Plans, Programmes and Policies on the Environment (200/2005) entered into force in Finland. In Sweden SEA is implemented by two acts, SEC and The Planning and Building Act. Even though this is not handled here in detail, also possible need for this has to be taken into account in the future work in the region.

> <u>Water management issue to be addresses</u>: Water related EIA
>
> Of the activities identified in the Espoo Convention, trading ports, dams and reservoirs, groundwater extraction activities, mining and deforestation of large areas are related to water management. In the Water Framework Directive, these activities represent pressures of human activities within the catchment. It is therefore recommended, that Environmental Impact Assessments of these activities are taken into consideration in the pressure and impact assessment against quality criteria of the WFD. In practise, this would mean that e.g. establishment of large dams and reservoirs would be assessed in reference to fish migration and effects of deforestation to water quality and hydrology would be investigated in the EIA. The next step in the EIA process would be creating alternatives to the activities from water management point of view.

2.2

Environmental legislation, permit procedures

Permit procedures and authorities

This part is mostly summarized from the Swedish translation of the Torne River work group memorandum (JSM 2002, Finnish version MMM 2002) with some updating and further commenting. In the report Finnish and Swedish environmental legislations were compared in order to analyze the possibilities and possible hinders for applying national procedures instead of the commonly agreed procedures of the Frontier Rivers Agreement. English translations for Finnish laws and decrees are from translations presented in the Statutes of Finland at www.finlex.fi. The major legislation viewed included the Swedish Environmental Code (SEC), the Finnish Environmental Protection Act (FEPA) and Decree (FEPD) and the Finnish Water Act (FWA) and Decree (FWD), together with some separately mentioned statutes.

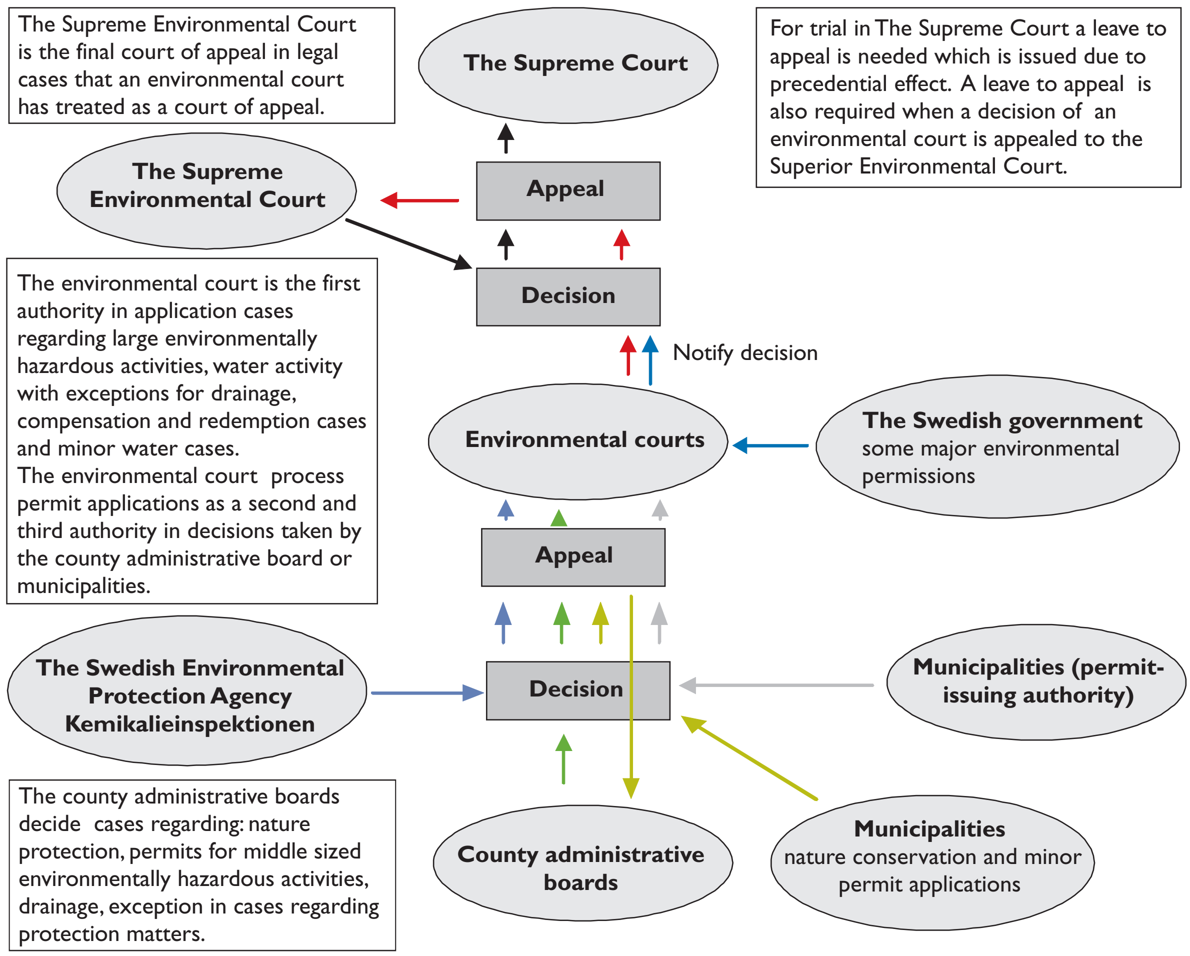


Fig. 1. The Swedish system of authority.

In Sweden the Government, county administrative boards (MPD:s) and other administrative authorities, municipalities, the environmental courts, the Superior Environmental court and the Supreme court deal with cases and matters governed by SEC. Decisions made by the municipalities can be appealed to the county administrative board (MPD). Decisions made by an MPD can be appealed to an environmental court etc. In some cases the Swedish government makes the decision about the permit. In those cases the case is returned to the permit authority, usually the environmental court, that authority will then give conditions for the hazardous activity (Fig. 1.).

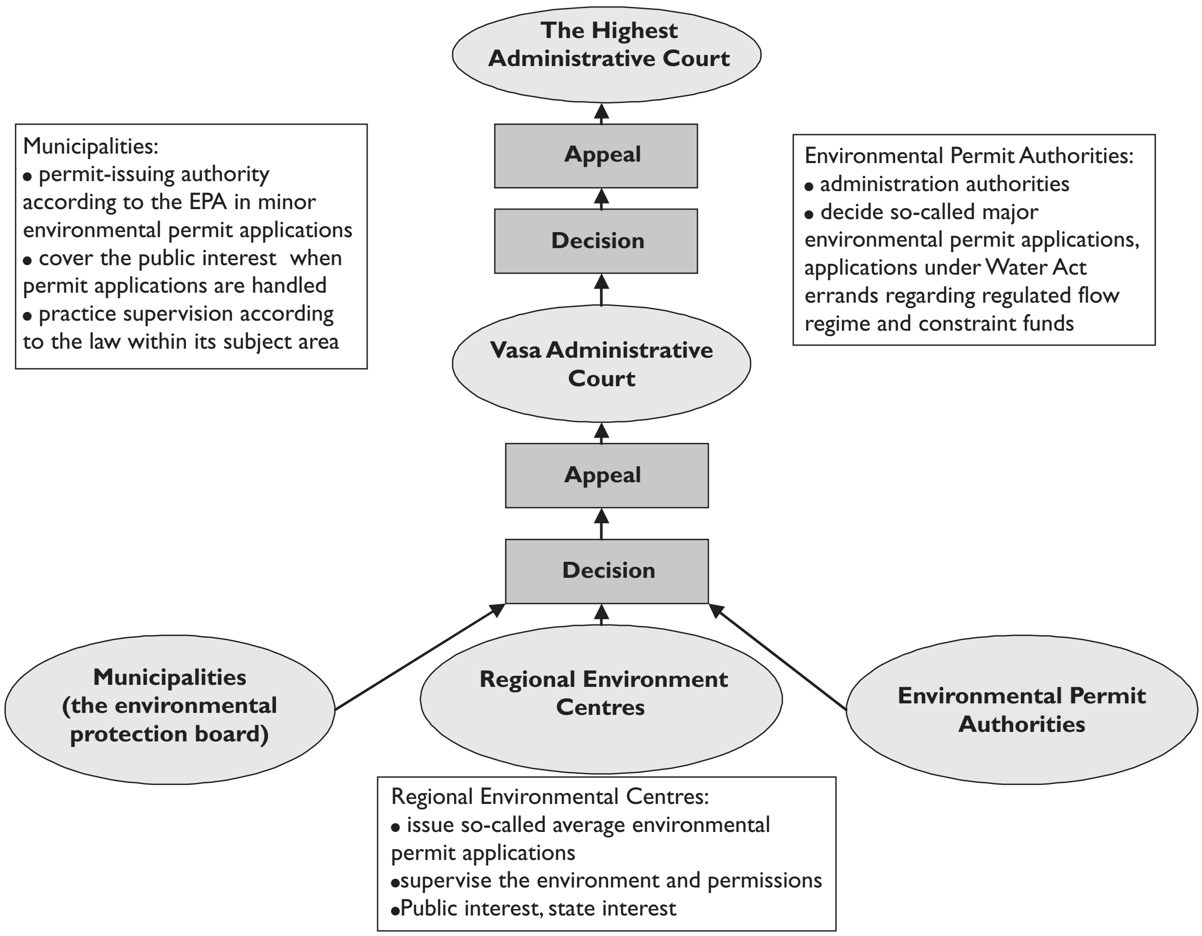


Fig. 2. The Finnish system of authority.

In Finland the main authorities dealing with enforcement and permit issues under FEPA and FWA are municipalities, regional environment centres and environmental permit authorities (Fig. 2). Some issues are handled by SYKE (Finnish Environment Institute) or the Ministry of Environment. The government does not directly participate in permit processes, but it has a possibility to make special legislation in issues considered to be of vital importance. FEPA and FWA and their additional decrees define actions needing permits, and corresponding permit authorities. Minor matters are handled by municipalities, medium size ones by regional environment centres and major matters including those defined in FWA and FWD are handled by environment permit authorities.

In the Torne River catchment area, the Finnish-Swedish Frontier Rivers Commission treats water issues, otherwise environmental permits are handled according to the national procedures.

Municipalities
In Sweden, the municipalities are qualified in nature conservation matters, in minor permits cases and in matters concerning health care. They also handle and make decisions in some supervision matters. Decisions made by the municipalities can in general be appealed at the county administrative board (MPD) and then to the environmental court. In Finland, the municipalities issue permits in minor cases according to the FEPA. As a major rule they are not authorized in matters defined in the Finnish Nature Conservation Act (1096/1996). Environmental permits are usually handled by the municipal environment protection committee, which also represents the public interest when permit applications are handled. The committee also enforces the law within its subject area.

The County Administrative Board (MPD)/The Regional Environmental Centre
The county administrative board makes decisions in cases regarding nature protection, permits for middle sized environmentally hazardous activities, drainage, exception in cases regarding protection matters like chemical products and minor water matters. The board also handles appeals regarding decisions made by the communities. The permit-issuing authorities in Finland most comparable to the Swedish county administrative boards are the regional environmental centres. One of their tasks is to issue so called medium large environmental permits. They also stand for the public interest in permit treatment and supervise and monitor the environment and permits issued by environmental permit authorities and regional centre.

The Courts /Environmental Permit Authorities
In Sweden, there are five environmental courts. The environmental court is the first application authority for cases regarding larger environmentally hazardous activities, water activities with exceptions for drainage, compensation and redemption cases. The environmental court is the court of appeal for decisions made by an MPD. There is one Superior Environmental Court which is the court of appeal for decisions made by the environmental courts. The Supreme Court is the final court of appeal for cases that started in an environmental court. For trial in the Supreme Court a leave to appeal is needed. The Supreme Court does that only if the outcome could have an precedential effect. When a case started at a lower authority and a decision of an environmental court is appealed at the Superior Environmental Court, a leave to appeal is also needed.

In Finland, the Environmental Permit Authorities are the closest counterpart to the Swedish Environmental Courts, but contrary to the Swedish system, they act as administrative authorities. The issues are dealt with and decided collegially. There are detailed directions for the procedure in the acts and decrees. The Environmental Permit Authorities decide on so-called major environmental permit applications, matters regarding water resources management and administrative constraints. They make decisions as the first authority. Vaasa Administrative Court handles appeals against the municipal environment protection committees, the regional environmental centres and the Environmental Permit Authorities. Decisions of Vaasa Administrative Court can be appealed at the Supreme Administrative Court.

In Finland there will be some further development in the process in the near future. The approach is to lower the number of authorities granting permits in order to simplify and unify the procedure.

The procedure in application cases

The rules of procedure

In Sweden, the rule of procedure in application cases is primarily described in the SEC. The Administrative Judicial Procedure Act and the Swedish Code of Judicial Procedure are applied in the second hand. The cases treated with the environmental court being the first authority are split into two different groups: application cases and sue cases.

In the Finnish legal system, the rules of procedure are found in the FEPA and FEPD, the FWA and FWD and in the Administrative Procedure Act (434/2003). The procedure according to the FEPA is a special kind of administrational procedure, which does not apply the SEC way of splitting the cases into application and sue cases or dividing into preparation and main negotiation. In cases regarding administrative constraint also the Penalty Payment Act (1113/1990) is applied. Some claims for compensation are treated in the same order as application cases. However, criminal matters are treated in the civil court.

The principle of judicial investigation

Both in Finland and in Sweden the principle of judicial investigation is applied in application cases, which means that the court is obligated to demonstrate the matter on its own initiative. The judgement can therefore not be based on the participating parties' permission. In application cases, the actor who has the duty to apply for the permit starts the process. In Sweden, some of the other concerned parties as well as the Swedish Environmental Protection Agency, The Legal, Financial and Administrative Services Agency and the county administrative board can start the process as well. In Finland the actor can be obliged to apply for a permit using a special procedure. Authorities can also start the renewal of the permit, and other parties can apply for starting a process. The rules of procedure in matters regarding water resource management are found in the FWA. The Swedish legislation does not apply to the FWA´s inspection procedure.

The right to appeal

The SEC uses a uniform way of defining the concerned parties, which decides who has the right to appeal. A relatively extensive group of concerned parties has the right to appeal. The right to appeal does not depend on the ownership of the property. The common right of access to private land is usually not a cause to appeal. However, professional fishermen have been seen upon as concerned parties, though their practise of the profession is based on the common right to fish. Non-profit environmental organisations have the right to appeal in Sweden. The organisation has to be open to the public and apply a democratic decision-making. The organisation must have been practising in Sweden during a minimum time stated by legislation. Their right to appeal is limited to application decisions.

In Finland, the right to appeal defined in FEPA is similar to the Swedish legislation. The rules differ from each other primarily for the restriction of rights for environmental organisations to appeal. In Finland it is limited to registered associations and foundations, but time limits or other rules for the activity are not applied. Employer or worker organisations have not been mentioned separately.

Currently, in Torne River catchment area, the decisions given by the Border River Commission can be appealed only in compensation issues, in Finland at Vaasa Administrative Court and in Sweden at the Superior Environmental Court.

Examination of applications and the content of the permit decisions

At examination of applications according to the SEC, an extensive comparison of interests is applied. The rules of principle are balanced in relationship to the scope and scale of the planned activity. The basic rule is written in the SEC 2 chapter 7 §. The rule includes a decree regarding the relationship between the cost and the benefit of a measure. The regulations that control the examination of applications in Sweden comprise largely the pollution of the environment. An example is the so-called principle of product choice. This means that the possibility to use a chemical product less harmful to the environment is investigated. In addition, recycling and re-use aspect should be considered. Above-mentioned details have no direct counterpart in Finnish legislation. However, the corresponding rules are included in the definition of best environmental practices and best available technology. Naturally, other legislation (Waste Act etc.) has to be observed.

Rules for activities that causes substantial environmental detriment (the so called stop rule)

In Sweden (SEC 2:9 and 2:10), activities that cause substantial environmentally detrimental effects can be allowed due to special reasons, even if the consequences causes conflict with the SEC. There are specific details on situations when the environmental interests have to stand back. In Finnish legislation, it is stated that the permit has to be denied if considerable environmental damage cannot be avoided even with stated permit regulations, thus the stop rule appears tighter.

The basics for inspection of applications are found in FEPA 41 § and the preconditions for granting a permit in 42 §. Also in Finland, it is considered that the inspection of applications should form a unit where the conditions for granting a permit and the terms of the permit should be dealt with simultaneously. With the FEPA Finland has resiled the comparison of interest that earlier was applied in matters regarding drainage of wastewater. Comparison of interests included the principle that the benefit and the inconvenience were balanced with each other. In examination of applications regarding water resource engineering the interest comparison is still applied according to the FWA.

The enforcement of a decision that has not reached validity

In Sweden, the environmental court can prescribe that the permit for an activity can be used even if the sentence has not reached validity, thereby the sentence/decision can be observed even if it will be appealed (SEC 22:28). The environmental court can prescribe that a sentence/decision has to be carried out when there is a reason for this. The Superior Environmental Court can remove the prescription. Finnish legislation has a comparable approach: enforcement can be prescribed before the validity of the decision. In addition, both according to FEPA and FWA, activities according the granted permit can be started (with certain limitations), before the decision has reached validity. This permission has to be applied for in the application.

Legal proceedings of conclusions

Swedish legislation has specific rules for the validation of a conclusion and the objective and subjective size of the binding effect (SEC 24:1). The main principle is that a decision prescribed by law in an application case and cases regarding water activity is obligating to all. In Finland there are no such directions regarding the validity or the binding effect of a decision in environmental permit and water resource engineering matters. The validity and the binding effect in these decisions are based on the rule which entitles to apply for changing a valid permit decision.

Review
According to the SEC a review can be applied both on questions regarding pollution and water resource engineering matters. In Finland this is handled differently, and adjustment of the permit conditions is in practice how the permit conditions are reviewed.

Water resource engineering
In matters regarding water resource engineering the Finnish legislation is stricter than the Swedish regarding the validity of the permit.

Compensation and damages

Compensation
In Sweden, the damages in matters regarding water resource engineering are compensated in connection to the consideration and decision of the permit, or later when a separate claim is made in court (SEC chapter 31). In matters regarding pollution of surface- and groundwater and matters regarding changing of the groundwater level, chapter 32 is applied. In Finland compensation and damages in water resource engineering matters are treated according the FWA (chapter 11), where a redemption for the benefit of a single person is allowed. Some losses are to be compensated up to one and a half times the amount. This differs clearly from the Swedish legislation.

In Finland, damages in pollutant errands can be compensated for in two different ways. Compensation can be decided according the Act on Compensation on Environmental Damage. Compensation for environmental damages are in general treated in the district court. Damages caused by pollution of watercourses are, however, an exception, and the compensations are set in connection with the applications, and they are decided by the competent authority together with the matter according to the principle of simultaneity. Questions regarding compensation due to pollution of watercourses can - as errands regarding water resources management -, be treated according to a consultation procedure or an inspection according to the FWA. In addition, the principle of judicial investigation is applied on them. Compensation motions, which have been claimed as separate applications, are decided by the Environmental Permit Authorities.

The responsibility for damages
The responsibility for damages is in principle strict in both states. In Sweden the rule softens a bit by the obligation to put up with disturbance (SEC 32:1). According to the SEC compensation rules, compensation for damage to a person, an object and capital is paid out. The base of chapter 32 is corresponding to the Finnish Act on Compensation on Environmental Damage. The relationship between the principle of judicial investigation and the compensations which are decreed in cases regarding water activities are written in SEC 22:22. Regarding the compensation takers, equality should be taken independent of the motions. The compensation may not be set lower than what the applicant has offered in the case. The agreement on compensation is cogent. The Finnish legislation has similar rules.

Compensation for unpredicted damages
According to the SEC, compensation for unpredicted damages can be decided in connection with application treatment in cases regarding water activities. The concerned can claim compensation at the environmental court of law. The claim should be made within five years or the maximum of twenty years if decided in connection with the permit. In Finland, compensations for unpredicted damages are

treated as application cases according to the rules in the FWA. An application case can also be a motion regarding compensation for damages that happened before the permit was issued and are based on the circumstances that the activity was run without permission (illegal).

Supervision, sanctions and fees

Rules of regulations

In Sweden (SEC 26), the most central authorities of supervision are the municipalities and the county administrative boards. A special ordinance has been issued regarding supervision (Förordning om tillsyn enligt miljöbalken 1998:900). The actor shall keep himself posted of how his activity affects the environment. Those who run an activity that affects the environment shall each year hand over an environmental report to the authority of supervision. There are detailed ordinances about the use of administrative constraints.

In Finland the supervision is carried out by the regional environmental centres and the municipalities. The basic rules regarding supervision and use of administrative constraints are written in FEPA Basic lines or detailed instructions on monitoring and environmental reporting are set in permit conditions. The difference between Sweden and Finland depend on the authority systems *i.e.* which authority is responsible for which issue. Annual reporting is a basic rule, information on activities has to be given more often, depending on the type of activity. Also in Finland, the actor has the responsibility to be aware of the effects on the environment.

Consequences of environmental crime

The earlier rules of environmental crime have been revoked and the new rules are concentrated to the SEC (chapter 29). The intention has been to get rid of penalties for undefined crimes and to have both the definition of the crime and the penal provision in the same section.

With the total revision of the Penal Code of Finland in the 1980´s and 1990´s it was assumed that all crimes that can be punished with an imprisonment according to special laws should be included in the Penal Code. In the special laws only crimes that can be ensued by fines remained. In chapter 48 of the Penal Code it is stated that crimes against the environment can be punished.

Environmental sanction fee

In the SEC there are many different kind of fees stated. The most important concerning the control is the environmental sanction fee (chapter 30). The environmental sanction fee is an administrative consequence type of sanction. The environmental sanction fee can be from 5 000 SEK up to 1 million SEK. The size of the fee depends on the type and extent of the activity. Finland has no consequence similar to the Swedish environmental sanction fee. However, in criminal matters there is a possibility for confiscation of benefit and community sanction fee for environmental crimes if not defined elsewhere.

Court costs

In Sweden, the rules on court costs vary depending on whether the matter or case is treated by an administration authority or a court. For the environmental courts, the main principle is that the rules in the court proceedings code that are valid for compensations for costs shall not be applied in cases regarding environmental hazardous activities (SEC 25:1). In applications cases regarding water activities the applicant shall, with some restrictions, answer for his own and the counterpart's court costs. Environmental organisations have nevertheless no right to get compensation for their costs and they are not obligated to pay for any court costs either. In application cases regarding rehearing and reviewing of permits each one pays for their own costs. When an authority starts the reviewing of a permit in order to see to the public interest, they cover (with some limitations) for all costs also for other parties including the costs for the owner of the permit.

In Finland the legal costs in matters regarding pollution are handled according to the FEPA. The general rule defined in the Administrative Procedure Act is that in an administrative matter everyone shall bear his/her own costs. The costs are only exceptionally compensated for. In addition, a separate Legal Aid Act defines possibilities for provisions on legal assistance given at the expense of the state. Costs needed for the hearing are set according to the principles in the Act on Criteria for Charges Payable to the State. The charges for a hearing of a compensation matter, which a party oneself has initiated, are comprised by a rule of exception, which admits compensation for costs for the treatment of the errand (FEPA 107 §). The criteria for compensation are regulated in the Administrative Judicial Procedure Act. The rules for compensation for hearings in water resources management cases are written in FWA. As a basic rule the parties bear their own costs.

Summary of the comparison of the environmental laws

The work group memorandum concluded that the Finnish and Swedish environmental legislations are relatively similar. The differences are especially found in the authority systems. The rules on environmental protection are nowadays mainly corresponding to each other. The rules regarding decisions on water resource engineering/water resources management differ slightly more than the rules on environmental protection. As the water legislations origins and ground principles are similar, these legislative differences are not decisively large.

A strongly contributing factor to the similarities between the environmental legislations in Finland and Sweden are the legislation within the European Community. In order to implement the IPCC-directive (Integrated Pollution Prevention and Control) both countries have founded a uniform environmental legislation. It can be expected, that on the basis on the effect of the fellowship legislation, the environmental protection rules in Finland and Sweden will become even more uniform in the future.

The largest differences between the environmental protection legislations of Sweden and Finland concern criteria for compensations and the decision on the compensations in connection to the permit hearing procedure. The differences in compensation criteria regarding questions on water resource engineering /water resources management are relatively small with the exception of the rule in the Finnish legislation regarding that some losses are compensated to one and a half times the amount. Finland has more extensive rules regarding pollution compensations and applies the principle of judicial investigation to a larger extent.

It was also noted in the work group memorandum that the differences in the water and environmental protection legislations constitute no obstacle to apply national rules instead of applying a common material substantive regulation in the Torne River Basin District. Also, if the legislation and permit authorities are decided in both countries national order of justice, experiences from the present system with local decision making and consultation should be made use of when the new system is created. The new agreement should contain detailed rules of the procedure, to secure access on information; public hearings and that the point of views from the border district are taken into account in the decisions.

Table 4. Basic rules and regulations that controls the water quality within the Torne River Basin District. (Parallel decrees and more specified legislation are not mentioned).

Activity	Laws and rules	
	Sweden	Finland
Forestry	Swedish Forestry Act (1979:429) Natura 2000	Forest Act (12.12.1996/1093) Natura 2000
Peat production	SEC (1998:808) Law (1985:620) regarding some peat deposits Frontier rivers agreement between Finland and Sweden (SFS 1971:850) Natura 2000	FWA (19.5.1961/264) FEPA (4.2.2000/86) Frontier rivers agreement between Finland and Sweden (SFS 1971:850) Natura 2000
Drainage	SEC (1998:808) Swedish Forestry Act (1979:429) Frontier rivers agreement between Finland and Sweden (SFS 1971:850) Natura 2000	FWA (19.5.1961/264) FEPA (4.2.2000/86) Forest Act (12.12.1996/1093) Frontier rivers agreement between Finland and Sweden (SFS 1971:850) Natura 2000
Settlement	SEC (1998:808) Planning and Building Act (1987:10) Frontier rivers agreement between Finland and Sweden (SFS 1971:850)	Land use and building act (5.2.1999/132) FEPA (4.2.2000/86) Frontier rivers agreement between Finland and Sweden (SFS 1971:850)
Building/ construction in water*	SEC (1998:808) Frontier rivers agreement between Finland and Sweden (SFS 1971:850)	FWA (19.5.1961/264) FEPA (4.2.2000/86) Frontier rivers agreement between Finland and Sweden (SFS 1971:850)

* The Frontier Rivers Commission decides on permits regarding building/construction in water both on the Swedish and the Finnish side of Torne River.

2.3
The Water Framework Directive

The European Union Water Framework Directive, WFD that was enacted in 2000 gives guidelines for water management policy for the member states. The directive has been considered to be the most important environmental directive in EU. The overall objective of the directive is to achieve a good state of surface waters including coastal waters, and ground waters by the end of 2015. WFD includes a set of stepwise procedures to plan water management to reach this goal. Management work is done within specified river basin districts, areas that are formed according catchment areas instead of traditional administrative units. The first river basin management plans are due to be completed by 2009. Each member state has to implement the directive to national legislation. Implementation of WFD also means implementing major parts of conventions mentioned earlier, whether or not they have been implemented before.

WFD procedures

As earlier mentioned, the aim with the WFD is to reach good status in all surface and ground waters in EU by 2015. For exceptional ground, the objectives can be lower, and also the target year for reaching the objectives can be prolonged twice, till 2021 or till 2027. For achieving this, a stepwise procedure has been set.

As a first step, preliminary evaluation of the pressures and impacts on waters, characterization of the river basin, was made by December 2004. Two years after this, in December 2006, first programme for monitoring the waters was to be ready. During this time also public consultation had to be started at the latest, which means at minimum public consultation or hearing period of six months for each programme and plan prepared. In 2008, a draft for a management plan for the river basin has to be presented, and next year, 2009, it has to be ready and complemented with programme of measures. This management plan has to be renewed every six years. Further, pricing policies for water have to be introduced in 2010. Programme of measures prepared earlier has to become operational in 2012. And, in 2015 the goal of good status is to be reached in waters.

The steps in the six-year cycle following each other are

1) **characterisation** of the river basin district and the different water bodies (lakes, rivers, stretch of coastal water), i.e. identification and description of the type of the water bodies.
2) defining good status and setting **environmental objectives** for the district and the water bodies
3) preparing **programmes for measures** that are needed for reaching environmental objectives (i.e. receiving or maintaining at least good status)
4) building a **monitoring programme** for ecological status to follow up possible long term changes, effects of measures or effects if activities or accidents
5) preparing **water management plans** to summarize current knowledge of status and pressure, and to frame needed measures

To be able to compare the work and results from different states, working groups have been developing guidance documents for different steps of implementation, national guidance is being made and intercalibration for quality methods and criteria has been going on. Despite this, the interpretations and procedures are not totally equivalent in different states. Further, there is not enough information for using all set criteria for most water basins. This has been noted also in Torne River area; see for example Elfvendahl *et al*. 2006. Finding the desired common view in an IRBD needs further pinpointing and harmonization of the most relevant issues.

For an IRBD, the WFD sets the minimum demand of harmonizing different aspects of the management work. To proceed in this, all steps have to be dealt with. This means using common tools for characterisation, i.e. describing the area and water bodies with the same terminology. This is needed for defining same criteria for good status, which again is elemental for setting common environmental objectives demanded at the minimum for the common water bodies, i.e. rivers, lakes and coastal waters shared.

Harmonization is needed in order to

- prepare **programmes for measures** that are needed for reaching environmental objectives (i.e. receiving or maintaining at least good status)
- build a **monitoring programme** for ecological status to follow up possible long term changes, effects of measures or effects if activities or accidents
- prepare **water management plans** to summarize current knowledge of status and pressure, and to frame needed measures.

Many of these issues are discussed already in chapter 2.1, under international agreements, as the WFD actually implements in more detail many of the agreements on Community level.

National implementation in Torne River IRBD

In Finland river basin management planning according WFD was adopted in 2004 with the Act on Water Resources Management (1299/2004) and the Decree on River Basin Districts (1303/2004), followed by the Decree on Water Resources Management (1040/2006) and the Decree on Hazardous and Harmful Substance on Aquatic Environment (1022/2006). Additionally some needed changes were made into the Environmental Protection Act and Water Act.

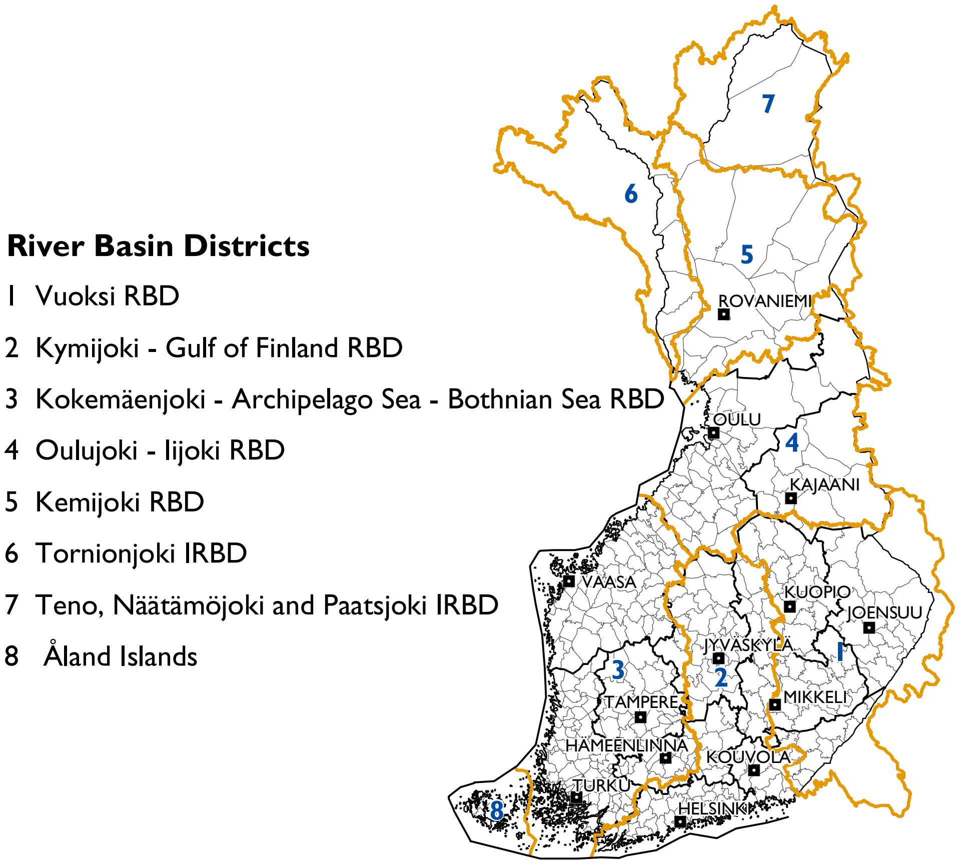


Fig. 3. River Basin Districts in Finland.

Finland is divided into eight river basin districts (RBD), two of which are international river basin districts (IRBD), i.e. Tornionjoki (Torne River) IRBD and Teno, Näätämöjoki and Paatsjoki IRBD (Fig. 3). Environmental regional centres are responsible for leading the planning processes, one centre working as the coordinative centre for each RBD. Joint working groups are set for RBDs with members from major authorities and stakeholder groups that are related to the use, protection and the state of the waters. Additionally, regional or subject related subgroups are used. Public hearing period lasts six months before the plans are to be in force. Results of the hearing are taken into account in the further work. The final water management plans are accepted by the Government.

In Tornionjoki IRBD, Lapland Regional Environment Centre is responsible for the management plans on Finnish side. For Lapland, one joint working group was invited for the regional cooperation, including also the work covering Tornionjoki IRBD.

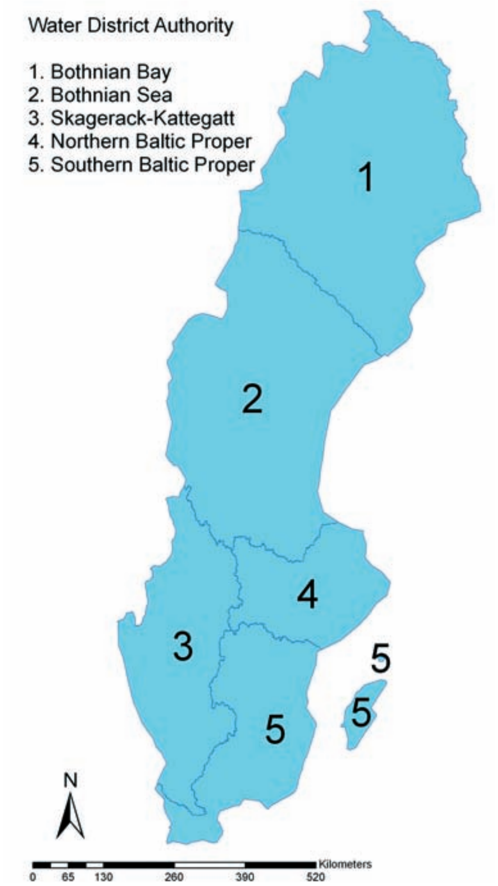


Fig. 4. River Basin Districts in Sweden.

In Sweden, organizing the river basin management work according WFD was settled with a decree 'Förordning om förvaltning av kvaliteten på vattenmiljön' (SFS 2004:660) and with changes needed in the environmental legislation (Swedish Environmental Code, SEC).

Five river basin districts were formed in Sweden (Fig. 4), and a new governmental agency, Water Authority, is responsible for the implementation of WFD. Water Authorities work at County Administrative Boards. The decisive organ in each Water Authority is Water delegation that has nominated members with expertise in different fields. Every county has regional secretaries that work towards the Water Authority. Reference groups are set for wider cooperation in the region. Public hearing periods last six months after the plans are in force.

Torne River area was set under Bothnian Bay RBD that covers the whole Norrbotten and part of Västerbotten. The competent water authority is the County Administrative Board of Norrbotten. Torne River IRBD has a separate delineation but is governed together with the rest of the area. Norrbotten has its own reference group that deals also with the issues concerning Torne River.

In October 2003, a note was exchanged between Sweden and Finland in which cooperation to fulfil demands set by WFD was officially agreed upon. Cooperation is realised at personal level in everyday work in Lapland Environment Centre and County Administrative Board of Norrbotten. So far there is no separate organ for the needed reconciliation. The reformation of the Finnish-Swedish Frontier Rivers Agreement is currently continuing. This will eventually lead to Frontier Rivers Commission being the coordinative organ (see more in Chapter 4) (Fig. 5).

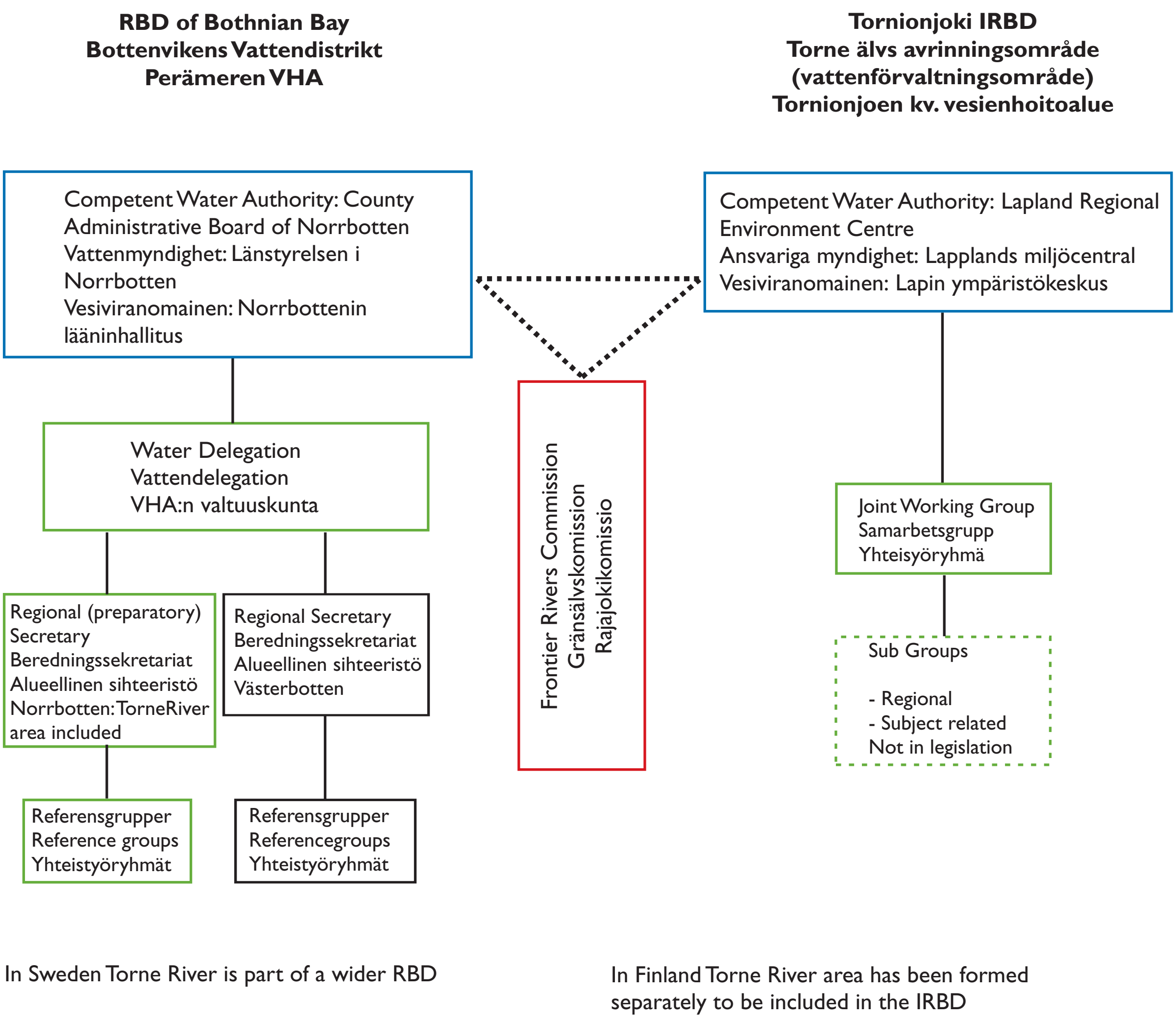


Fig. 5. Management system in Torne River in Sweden and Finland. Frontier Rivers Commission is mentioned here even though it is not currently authorized in the issue.

Minor areas of the northernmost part of the Torne Rivers catchment area are in Norway. Norway is not a member state of EU, but has a close relationship with it through the European Economical Area (EEA) agreement. This agreement allows Norwegians an unhindered access to the internal market of EU in major issues, and in exchange obligates Norway to adapt major part of EU legislation including WFD. Norway has informed that it will implement WFD with a delayed schedule. The law arranging the water management entered in force in January 2007. According this Norway is divided into nine river basin districts. Minor headwater catchment areas of Torne River reach up to RBDs of Nordland, Troms and Finnmark. The form of the official cooperation dealing with the international river basin district issues between the three states will depend also on the decisions made in Norway. This part is open.

Many parts of the final implementation – and implementation of the national legislation - are still open. Some issues have been under discussion in both Finland and Sweden. One of them is the validity of the quality criteria, or ecological quality objectives for different water basins. In Finland and Sweden the management plans bind all authorities, i.e. they always have to take them into account in their decisions. The plans do not bind individual actors directly, but as they will be taken into account in the different authorities' decision making processes, it can be argued that they are "indirectly" binding or controlling. In an IRBD, unmatched schedules do not make possible to use the same public hearing periods on both sides of the border. It is also more difficult if not impossible to pace the work in the region – when in the other state the documentation has to be ready and published for consultation, the other state is still only preparing them. In these early phases of common management work the difficulties are more striking, when national guidance and standards are only under preparation. To simplify the work, the six months public hearing must be harmonized.

When the final management plan is prepared, in Sweden the Water Authority makes the decision on the plan. In Finland, the Government takes the final decision. In the draft for the new Frontier Rivers Agreement, it has been defined that the Frontier River Commission accepts all the plans, but whether there will be an additional national protocol after that, is not described, nor are the changes possibly considered for the national legislation described.

Participation in WFD procedure

Both in Sweden and in Finland the minimum level of participation procedures in WFD issues is defined in the legislation. In Finland, these minimum levels, separately named participation forms are the regionally formed, representative joint working groups and public hearings. The meetings of the joint working groups are open for public and media. In Sweden, the respective forms are reference groups and public hearings. Otherwise, the forms of participation have been left open for the regions to decide upon the needs and resources.

In both Finland and Sweden, specific work groups have been formed to work on heavily modified waters. In Finland possibilities for regional groups have been discussed. A few public occasions for discussing the water management issues have been arranged. In Sweden, there is an ongoing process for activating and arranging regional participation in form of 'Vattenråd', water councils ('Vattensamverkan Norr' project). Regional start-up meetings have taken place under 2007 and the work will develop further in 2008.

In Finland it has been pointed out that resources for arranging and developing participatory work are lacking nationwide (Laurinolli 2007). In Torne River RBD the vast geographical area and partially very scarce population set challenges for participation, and the insufficiency of resources can possibly hinder even more severely the development of good and active interaction than in other, more 'compact' areas. On the other hand, in this region cooperation across the border has traditions, and during recent years it has been increasing and widening in many fields. The challenge is to find both cost effective and working means of participation.

Some examples of issues to harmonize in WFD work

Protected areas

According to appendix IV in the WFD each member state needs to keep a register over their protected areas. The register should include five different categories, for example bathing water, nutrient sensitive areas and areas designated for the protection of habitats or species including relevant Natura 2000 sites. Nationally the implementation can differ between the countries, for example, in how Sweden and Finland have interpreted the directive and their decisions on limit values.

The differences are stated below. Bathing waters are handled in more detail under international agreements, Water and Health (chapter 2.1). From other issues regarding protected areas, economically important species is not relevant in the Torne River area at the moment since it points mainly to the 'mussel directive' and is therefore not treated further.

In Sweden it is the water authority who will see to that there is for every water district a register of the protected areas according to 2 § chapter 3 in the decree (2004:660) "Förvaltning av kvaliteten på vattenmiljön". The register should be kept updated and include all protected areas according to the WFD. The register should not include other water bodies or protected areas than the ones that have been pointed out by the Swedish rules stated. The water authorities can of course make a complementary register with information regarding other protected areas to support their work. These areas will not be reported to the Swedish Environmental Protection Agency and the EU and will not be counted as protected areas defined in the decree. (Naturvårdsverket 2007a)

The Swedish EPA considers that the areas included in the register of protected areas are limited to those where it is obvious that the conservation or improvement of the status of the water is an important factor for the species and the nature habitats to be protected in the area. They further suggest that the starting point for the selection of the ecological criteria to identify Natura 2000-habitat and species are the ones that are suggested in the EU-guidance (CIS no. 12). Some species are difficult to group since they do not clearly fulfil the criteria. The different Swedish ecological criteria is presented in table 5. (Naturvårdsverket 2007b).

Table 5. Ecological criteria for identification of water related Natura 2000 species and habitats in Sweden.

Natura 2000-species	Natura 2000-habitats
1a Aquatic species that lives in surface water according to definition in Article 2 in the WFD.	2a Habitats consisting of surface water or totally existing in surface water according to definition in Article 2 in the WFD.
1b Species with at least one aquatic life stage dependent of surface water.	2b Habitats dependent of regular overflows of surface water or ground water level.
1c Species dependent of non-aquatic, but water dependent, habitats belonging to category 2.b and 2.c in the habitat column in this table.	2c Non aquatic habitats dependent of influence from surface water, for example spray, humidity caused by surface water, mechanical influence,

For group 1a it is suggested that also species (animals) that do not fulfil the criteria "Lives in surface water" (1a) but are very dependent on water, for example that their nutrition is water dependent (otter, some water birds) are included since they are completely dependent on the quality in the water environment.

Some vascular plants and mosses that live in the transition zone between land and water, or are found both in wetlands and nearby open surface water, and are dependent of the structures and functions that are created/supplied by the open water can also be grouped into 1a. According to the guidelines should they be grouped as 1c since their habitat are 2b (dependent on regular overflow of surface water or ground water level) or 2c (non aquatic habitats dependent on influence from surface water, for example spray, humidity caused by surface water, mechanical influence). To be consistent with the interpretation it is suggested that these species are included in group 1c.

Swedish Environmental Protection Agency also suggests that the areas where the species according to criteria 1a and/or nature habitats according to criteria 2a are included in the decision regarding protection of the area should be included in the register, but not areas with lower criterias as 1b, 1c, 2b and /or 2c. For specific reasons exceptions can be made. It could then concern some areas with 1a- or 2a-criteria that are not included, or areas with 1b- or 2b-criteria that are included after an expert judgment. Exceptions can for example be done regarding size, distance to water body or threat.

Species and nature habitats with the criteria 1c and 2c should in most cases not be included, but well motivated exceptions can occur. Some areas with species that belong to group 1c could for example be included in the register since they are often related to habitat 2b (depending on regular overflow of surface water or ground water level). Motivations are suggested when exceptions are made. (Naturvårdsverket 2007b).

Sweden has identified 78 species and 52 habitats to be aquatic relevant. Of these, 33 species belong to category 1a, 4 to 1b, and 41 to 1c. Of the different habitats 18 are said to belong to 2a, 19 to 2b and 15 to 2c. Within the Torne River area we have five species that belong to category 1a, one to 1b and two to 1c. Counting the habitats we find seven category 2a, four 2b and one 2c. Complete lists of water related species and habitats for both Sweden and Finland will be found on the website www.triwa.org.

Sweden has pointed out the whole Torne and Kalix Rivers including their tributaries as one N2000 object (SE0820430). Currently it is sorted out which of these waters are to be included in the register of protected areas.

The Finnish Environment Institute identified the Natura 2000 species and habitats related to water for the WFD register of protected areas in 2006 with a quite similar approach than in Sweden. Briefly, in Finland eight inland water habitats, eight sea and coastal habitats and seven semi-aquatic habitats were identified as water related Natura 2000 habitats together with 22 species specified in the habitat directive. These criteria with additional 56 bird species of the birds directive and nationally endangered fish species, were used in selecting the sites for the register. Although Finland has an official exemption from EU for European beaver (*Castor fiber*), spined loach (*Cobitis taenia*), bullhead (*Cottus gobio*), lamprey (*Lampetra fluviatilis*), brook lamprey (*Lampetra planeri*) and asp (*Aspius aspius*) and salmon (*Salmo salar*), nationally endangered fish species were used as national criteria of selection (Table 6). The exemption means that these species are not legally binding by EU in Finland for establishing protected areas.

Table 6. Nationally endangered fish species in Finland, scientific name, Finnish name, Swedish name and endangered class.

Nationally Endangered Fish Species	Endangered Class
Salvelinus alpinus, nieriä, röding (Lake Saimaa area)	CR
Cobitis taenia, rantaneula, nissöga	EN
Salmo salar, lohi, lax	EN
Salmo trutta m. *trutta*, meritaimen, havsöring	EN
Aspius aspius, toutain, asp	VU
Coregonus lavaretus lavaretus (*C. lavaretus*), vaellussiika, älvsik	VU
Coregonus lavaretus pallasi (*C. pallasi*), planktonsiika, aspsik	VU
Coregonus lavaretus nilssoni, järvisiika, planktonsik	NT
Lampetra fluviatilis, nahkiainen, flodnejonöga	NT
Salmo trutta, taimen, öring (sisävesimuodot, järvitaimen ja purotaimen)	NT
Salvelinus alpinus, nieriä, röding (elsewhere than in Saimaa area)	NT
Thymallus thymallus, harjus, harr (sea populations)	NT
Vimba vimba, vimpa, vimma	NT

In the Finnish proposal of Natura 2000 areas to be included into the WFD register of protected areas, the complete water course of River Torne and River Muoniojoki (FI1301912) has been assigned based on occurring salmon species while bird species are the basis for inclusion of the Natura 2000 area of Lake Karunginjärvi (FI1301913). 11 water related habitats occur in the Finnish side of Torne River Basin (Table 7.)

Table 7. The following 11 water related habitats occur in the Finnish side of Torne River Basin according to the Finnish assessments (Finnish Ministry of the Environment, 2007). **Also basis for the Swedish N2000 site. One additional habitat was also included: Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*; (Natura habitat 3130).

N2000-code	Habitat
1130	Estuaries
3110	Oligotrophic waters containing very few minerals of sandy plains
3160**	Natural dystrophic lakes and ponds
3210**	Fennoscandian natural rivers
3220**	Alpine rivers and the herbaceous vegetation along their banks
3260**	Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation
6450	Northern boreal alluvial meadows
7160	Fennoscandian mineral-rich springs and springfens
7220	* Petrifying springs with tufa formation (Cratoneurion)
9080	* Fennoscandian deciduous swamp woods
91E0	* Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)

There are also four water related species of Natura 2000 on the Finnish side of the River Torne area.

Lutra lutra – European otter (NT)
Margaritifera margaritifera – river pearl mussel (VU)
Dytiscus latissimus – predacious diving beetle (LC)
Arctophila fulva var. pendulina – pendant grass (CR)

Sweden has identified these species to be the basis for pointing out the N2000 site:

Lutra lutra – European otter (NT)
Margaritifera margaritifera – river pearl mussel (VU)
Ophiogomphus cecilia – Green Club-tailed Dragonfly (LC)
Salmo salar – Atlantic salmon (EN)
Cottus gobio – European bullhead (LC)
Trisetum subalpestre – No common name (NT)

Of these species, pendant grass is the most threatened (CR) followed by river pearl mussel (VU). All the identified habitats and species are likely to influence the environmental objectives of related water bodies in both countries. More species and habitats may occur within the area since the knowledge of this vast area is scarce.

In Finland, preliminary proposals have been made for establishing joint monitoring activities for Natura 2000 and WFD purposes. Similarly, using the protection of the water related habitats and species as water management objectives have been proposed so that protection of habitats and species occurring in a water body are given first priority in water management. For the Natura 2000 areas, the proposed water management activities include production of management and maintenance plans in which the water related habitats and species are focused on.

Water management issues to be addressed: Environmental objectives and programme of measures

The Natura 2000 areas, i.e. complete water course of River Torne and River Muoniojoki (FI1301912), Lake Karunginjärvi (FI1301913) specified in Finland and Torne and Kalix River system (SE0820430) in Sweden, are likely to require environmental objectives based on nature conservation. In practice this means, that the salmon species and bird species would set priority protection targets that are priorities in relation to WFD targets.

Of the other Natura 2000 conservation values it is proposed, that the identified water related Natura species and habitats that occur in Torne RBD are considered as environmental objectives in the water bodies that these conservation values occur. At minimum, conservation of the pendant grass (*Arctophila fulva var. pendulina*) and the river pearl mussel (*Margaritifera margaritifera*) are likely to influence environmental objectives. At maximum, ensuring river pearl mussel migration into new suited habitats via salmon migrations can be considered as an objective. This could lead into an assessment, where free salmonid migrations are estimated based on the existing river pearl mussel populations and available habitats for the species. It is recommended, that protection of water related habitats is utilized as environmental objectives.

It is advisable to include water related nature conservation activities into the maintenance and management plans of national parks and consider joint monitoring possibilities for Natura 2000 and water bodies of WFD.

It is recommended, that possible field inventories of water related Natura 2000 habitats and species are included in the programme of measures of water management plans. Similarly, the joint monitoring activities could be included in the monitoring programmes. In addition, the official status and the legislation protecting the Natura 2000 areas may be included in the programme of measures, since this legislation defines the means of protection and utilization possibilities of the water bodies in question. In Finland, Natura areas can be protected by several pieces of legislation. The usage of maintenance and management plans in more detailed water management in Natura 2000 sites is also recommendable as one programme of measures.

It is proposed, that the Finnish and Swedish approaches composed of water related habitats and species are combined for defining water management objectives and activities for the area. Similarly, production of joint management and maintenance plans for Natura 2000 areas with water related habitats and species is recommended. In practice, the habitats and species used in selecting the relevant Natura 2000 areas form the basis for water management objectives and water management activities to be included in other plans such as the maintenance and management plans.

Areas sensitive to discharge of nutrients

Areas that are sensitive to discharge of nutrients, including areas that have been declared as vulnerable according to the directives 91/676/EEG (nitrate directive) and 91/271/EEG (urban waste-water treatment) are to be included in the register defined in WFD.

Sweden has decided that all urban areas need to purify the wastewater from phosphorus and according to 6 § SNFS 1994:7 that the wastewater also have to be purified from nitrogen if it is released in an area sensitive to nitrogen. In 5 and 7 §§ SNFS 1994:7 it is stated that discharge from urban areas that reach the coastal waters from Strömstad in the west to Norrtälje in the east should be purified from nitrogen. This means that the whole Swedish territory is sensitive to discharge of nutrients from urban wastewater, but the necessary protection needed is different. Whole Sweden except the coastal water from Strömstad to Norrtälje is sensitive to discharge of phosphorus and the costal water is sensitive to both phosphorus and nitrogen (Naturvårdsverket 2007).

Whole Finland has been assigned as a vulnerable zone defined in the nitrates directive. It is however interpreted so that the specifically high nitrogen reduction of wastewaters is to be used according the regional situation. Phosphorus reduction has been used for municipal and industrial wastewaters for decades, and the most effective systems can reach even over 99 % reduction. For nitrogen, reduction demands are common, but the percentage changes according the type of the point loader and region. In addition, the Government Decree on Treating Domestic Wastewater in Areas Outside Sewer Networks (542/2003) has set high demands for the efficiency of the wastewater treatment systems in even single houses and farms.

2.4
Other relevant planning processes

Land use planning is in both Sweden and Finland the right and responsibility of the municipalities. The Finnish principles are described in the Land Use and Construction Act (1999) and the Swedish in the Planning and Building Act (1987:10). The Land Use and Construction Act was a major renovation in the land use legislation. In Finland, there are basically three levels of land use plans, with different scale and scope and binding effect. In Sweden, there is a similar system, but only with two important management levels. The regional level, encompassing a number of municipalities that are somehow coordinated, is not compulsory and therefore not well developed. In practice, it is used in a few heavily urbanized areas like the Stockholm region.

Water management is closely linked with land use planning. Issues like water supply, nature protection, and environmental protection have to be taken into account in all planning processes. In Finland, all authorities have to take water management plans into account in their actions and plans (Water Management Act). However, land use planning was delineated off this project, and it is only briefly referred to in some contexts. Possibilities and prerequisites for further development of cooperation across border in planning processes should be handled in the near future, possibly in a separate project.

<u>Issues to solve</u>

The differences in WFD implementation that can hinder the practical work in the region has to be harmonized. Some issues that have become apparent are mentioned here.

The delineation of the RBD is different in the states: in Finland Torne River is separately defined, in Sweden it is currently part of a wider RBD in Sweden. Work on the Swedish side of the border could be simplified by separating the Torne River part of the RBD. This could facilitate the further harmonization It is not totally clear, will Sweden separate the region after the new Frontier Rivers Agreement is implemented.

Schedule: Even though the schedule for implementing WFD is basically the same due to the set dates in the directive, the difference in the timing of the public hearing period leads into several months difference in Swedish and Finnish side of the Torne River IRBD. To facilitate common work it is recommended that for the IRBD the public hearing period be harmonized.

Differences in national typology and classification: Differences in typology and classification are the elementary issues to harmonize, as all management work is based on these.

Status objectives: procedure for setting common objectives for the common water basins has to be formed and agreed upon.

Participatory processes: How the participation in the region can be arranged to provide possibilities for genuine and democratic interaction.

Register of protected areas: differences to be harmonized and the approach for management and maintenance plans solved.

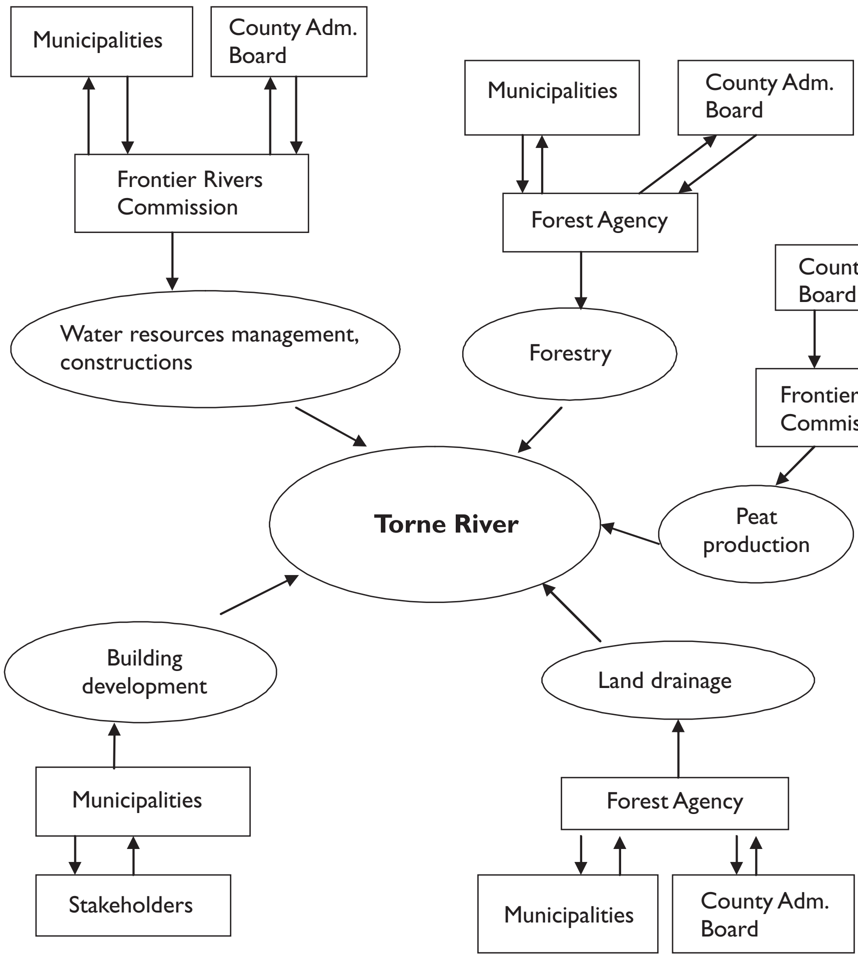
3. Institutions and administrative processes and practices

Water quality in a particular lake, stream, coastal water or ground water is a result of human use over time in combination with natural characteristics of the area. The human/social management control of how water quality is changing and evolving over time is regulated on a general level by legislation etc., but on a more detailed level by how the system of rules and regulations is applied by certain organisations in their administrative procedures, decisions and daily practical work. The aim of this section is to describe the most important institutions in the Torne river watershed and the water quality relevance of their specific administrative decision making procedures.

3.1 Institutions

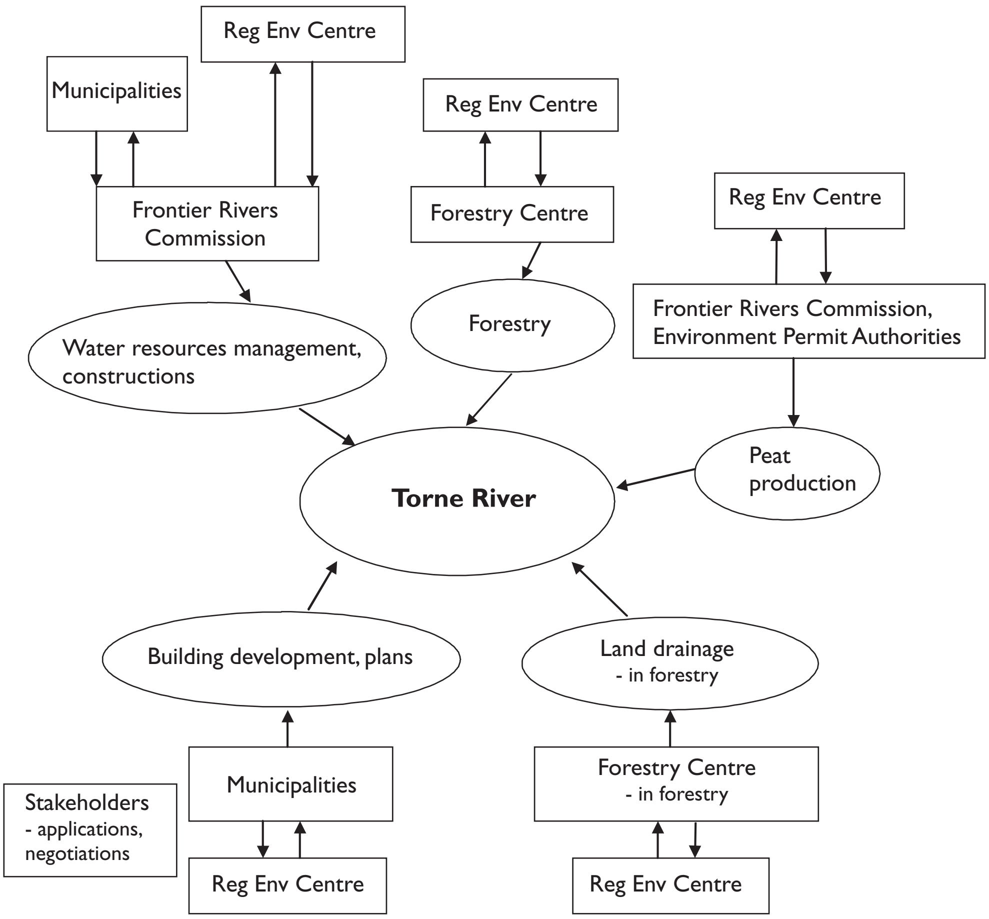
The most important human activities for the future water quality of the Torne river drainage area are forestry, land drainage, peat harvesting, building/infrastructure development and waterworks. Also mining is of an increasing importance. Number of institutions is involved in taking decisions on and thus regulating these activities. Principally, in both Sweden and Finland there are three levels of decision making; central, regional and local. In practice there are many similarities but also some differences between the management systems in the two countries. In the maps below, delineation has been to the regional decision making, not including the political decision making. In many cases decisions are made also at ministries, or government level has effect on these issues. The ordinary citizen/stakeholder is not mentioned separately here, but usually has the right to give statements, express opinions or complain etc. in most of the decision processes.

In Sweden the institutional and decision making “map” regarding the most important activities for the control of future water quality in the Torne river watershed can be described as follows:



In Sweden the three levels are the central government in Stockholm, the county administrative board in Luleå and the municipalities. In Finland they are the Environment Permit Authority (Oulu), Lapland Regional Environment Centre in Rovaniemi and the municipalities. Municipalities have the planning monopoly. There are also issues handled by for example Environment Ministry. The two countries also have a joint institution, the Frontier Rivers Commission in Haparanda that has a decisive role in water related permits.

In Finland the institutional and decision making “map” regarding the most important activities for the control of future water quality in the Torne river watershed can be described as follows.



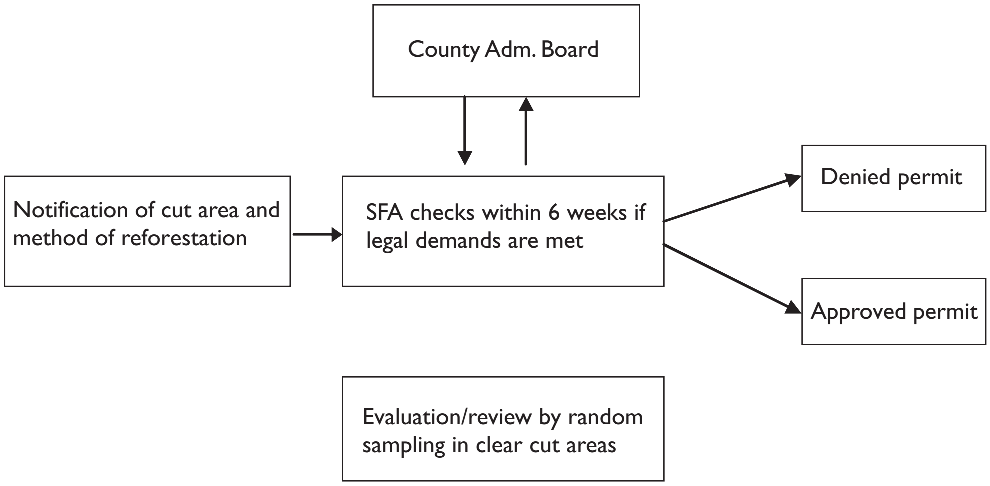
3.2

Administrative decision processes

The laws on water quality are put into practice by institutions who work according to different administrative procedures. The characteristics of these procedures in practice are therefore important when describing how water quality is actually controlled.

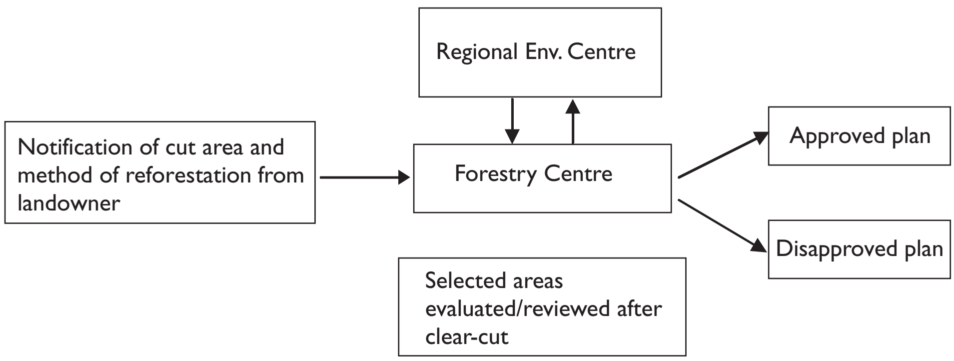
Forestry in Sweden

If a forest owner wants to cut his forest he must notify the Swedish Forestry Agency (SFA) that must respond within six weeks. Most notifications are approved. Swedish legislation requires a somewhat higher level of environmental consideration than in Finland. The notifications can in some cases be denied, usually because the forest is not old enough or because there are many clear-cuts in the surrounding area. An actual permit is sometimes necessary when the clear-cut is located in a sensitive area. The owner must always take into consideration if his property lies within a Nature 2000 area. The SFA can request a statement from the County Board of Administration if a forest owner wants to cut his forest in an area with certain high natural values.



Forestry in Finland

In Finland, Forestry Centres (FFC) act as responsible authorities in matters under Forestry Act, and they are the authorities responsible for granting state subsidies for forestry (under the Act on Financing of Sustainable Forestry). If a private forest owner wants to cut his forest, he therefore notifies the Forestry Centre. Most complaints in the evaluation concern how reforestation is made. The Forestry Institute can also ask for a statement from the Regional Environment Centre, and this is usually done in specified cases in vulnerable areas (ground water areas, special protected areas etc.). Each forest planner at FFC makes decision on the need for a statement. The state owned forests are mostly governed by Metsähallitus, and it acts independently. There are national and regional guidelines set for taking for example environmentally sound techniques and biodiversity into account. The whole concept is different from the Sweden.

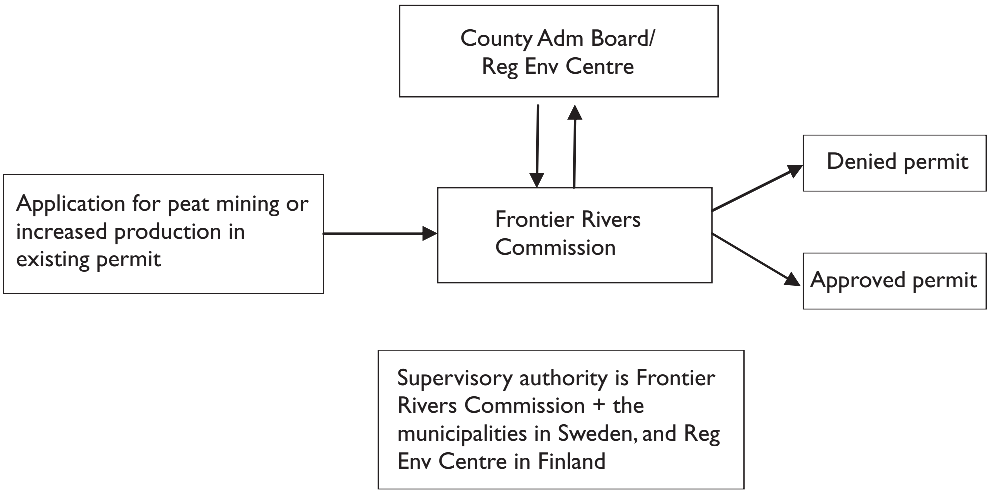


In Finland, the maintenance of the forest drainage system (ditches) is emphasized much more than in Sweden, also since there is a long tradition in subsidising this field by the Finnish government. In practice, these activities have been much more intensive in Finland than Sweden during the last decades. Partly this is due to the practice of not maintaining/clearing of the old ones, but also making new ones, i.e. the new guidance has been to make density higher in areas where ditching is considered useful/needed, but also giving stronger guidance on where the ditching is useful and where not acceptable. This practice is not allowed in Sweden.

Application for drainage permit is done at the Border River Commission within the Torne River Basin District. Application or notifications regarding ditching for clear cuts and forest management is done at SFA in Sweden and at FFC in Finland. The Border River Commission, in consultation with the concerned authorities in both countries, carries out supervision of the errands they have permitted. SFA and FFC carry out supervision on ditching in connection to clear cuts or forest management. In practice especially the old type of forest drainage activities have had an important impact on especially smaller lakes and streams in the Torne River catchment area.

Peat mining in Sweden and Finland

The Frontier Rivers Commission decides on new, prolonged or increased permits for peat mining in the Torne River catchment area. The Commission asks for statements from the environmental unit at the County Administrative Board of Norrbotten (CAN) if the application concerns Sweden and from the Lapland Regional Environment Centre (LAPREC) if it concerns Finland. Applications are usually approved, but in some cases can be denied for example because of Nature 2000 regulations.

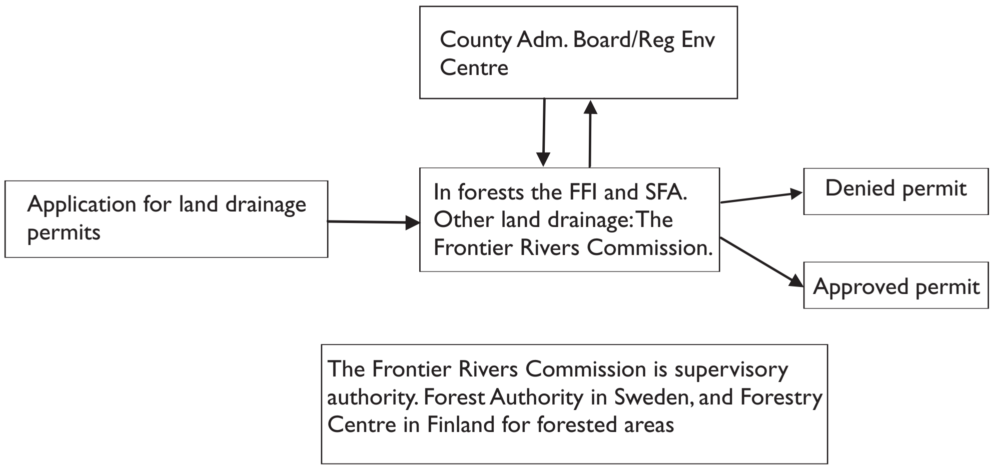


In Finland the legislation used on peat mining is generally more related to water legislation due to the long existence and scope of the Water Act, whereas in Sweden it is more related to the mining legislation.

Peat production areas are much more common in Finland than in Sweden, since the tradition is much longer. The Swedish peat areas are usually run by sister companies for Finnish peat production companies.

Land drainage in Sweden and Finland

Land drainage can be for instance the drainage of forested land or of wetlands for building/infrastructure development. For such activities you must always apply for a permit, and in most cases, you apply at the Frontier Rivers Commission. In forested areas in Finland though, you do not apply for permit but to gain the subsidies you notify the Forestry Centre, and in Sweden, you apply for the permit at the Forest Authority. It is also Frontier Rivers Commission who is supervisory authority, in cooperation with relevant authorities in Finland and Sweden, for the permits they approve. In forested areas, the Forestry Centre and the Forest Authority respectively, have the same task.

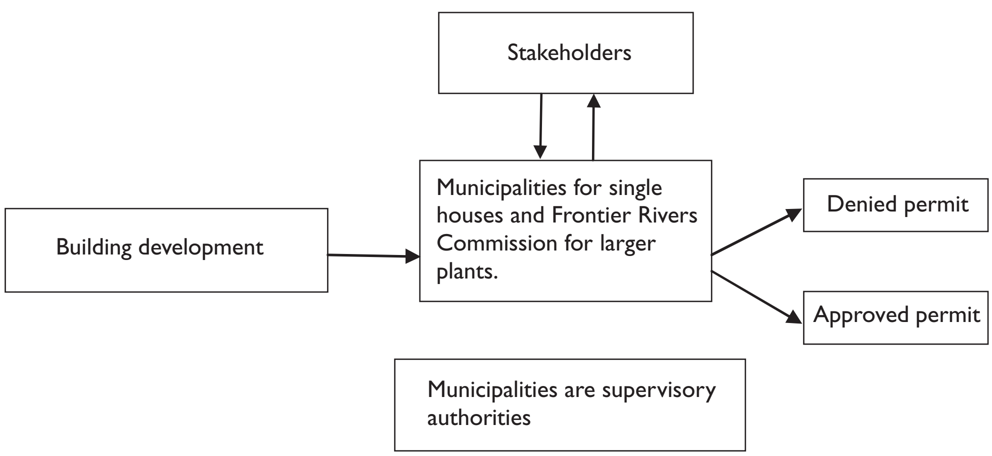


A difference between the two countries is that in Sweden it is necessary with a separate permit for draining when developing in wetland, but in Finland the need for permit is dependent on the case (target, ownership, scale, effects) with delineations given in the Water Act.

Building development in Sweden and Finland

The primary source of impacts from building development on water quality in the Torne River drainage area is sewage wastewater from single houses as well as larger wastewater treatment plants. The municipalities approve wastewater treatment systems for single houses in both Finland and Sweden. The County Board of Administration in Sweden first approves larger wastewater treatment plants. The Frontier Rivers Commission makes currently the final decision in Torne River area. The municipalities are supervisory authorities for all cases in Sweden, in Finland it is LAPREC for the plants licensed by FRC.

Each application permit for single houses is individually analyzed, e g each location is analyzed regarding its suitability for wastewater discharge. The technology commonly used is infiltration in existing soil or a sand mound but also other methods are used.

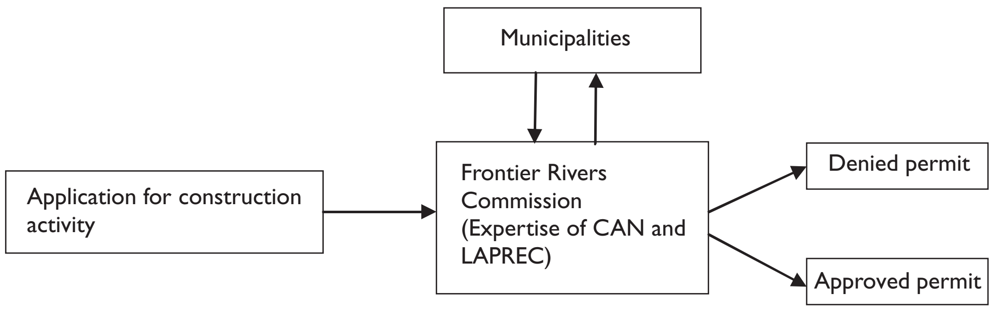


The Finnish legislation has stricter limits for loads from sanitary wastewaters than in Sweden. Recent Government Decree on Treating Domestic Wastewater in Areas Outside Sewer Networks (542/2003) has given detailed standards for the demanded efficiency of the treatment systems, with some discretion possibilities.

In Finland it is generally easier to get a permit for building development closer to a waterfront than in Sweden. In Finland basic regulations for this are given in the Land Use and Building Act (132/1999) and more detailed limits in valid plans if they exist for the area. Construction permits within these plans are given by the municipality and when an exception permit is needed (either differing from the valid plan or in areas with no valid plan) in shore areas, the regional environment centre is the responsible authority.

Water resources management in Sweden and Finland

Water resources management or construction in water can be for example harbour constructions or dredging activities. This includes also restoration of impacted sites. The Frontier Rivers Commission is the permit authority in these issues in the Torne catchment area. They do get expert assistance from CAN and LAPREC. The municipalities always can express their view on the application.



In Finland, it is often not necessary to apply for a permit for minor constructions like a small floating summerhouse jetty, though notification is commonly asked in municipal building code, whereas in Sweden a notification or permit application often is necessary according to the legislation. In the Frontier Rivers Agreement a right for building minor constructions with certain limitations is given.

3.3 Conclusions

The differences in organisation and administrative processes regarding water quality control between Finland and Sweden are - overall - relatively small. The responsible authority can be different according the matter, and there are issues that are handled in a different way due to historical and legislative differences, but the objectives are somewhat the same.

It can be concluded that a number of prerequisites for comprehensive water management planning in the Torne river watershed are in place. This is further emphasized by the existence of a joint institution with responsibilities in this field, The Frontier Rivers Commission. It is however also important for the effectiveness of water management that further harmonization can take place in the legal and administrative systems of the two nations. Whether the differences increase if the permit procedures are shifted under national decision-making is hard to say. The role of the FRC in the future and the national authority systems' attitude towards the views expressed by the commission have particular influence on this.

4. Cooperation, Governance and Roles for the Commission

4.1

Finnish-Swedish Frontier Rivers Agreement and Commission

Finland and Sweden signed in 1971 an agreement where the states agreed upon cooperation in issues regarding transboundary waters. Following year, Finnish-Swedish Frontier Rivers Commission (later FRC) formed by six members started working. Each state appoints three members, chairmanship and vice chairmanship alternating annually. Of these, one is to have legal qualification and experience of judgeship, one to have technical expertise, and one to have knowledge of the border area. The FRC handles the application and administrational measures defined in the agreement, i.e. it acts as a permit authority.

The agreement covers measures involving construction in water, water regulation and risk of water pollution in the specified area. Regulations for fishing are also part of the agreement. Interest of nature conservancy is separately mentioned, claiming that as far as possible, the fish stock shall be safeguarded and water pollution counteracted. Ground water issues are included with statement that provisions relating to construction in water shall apply a measure in a water area that may affect the ground water conditions. The agreement also acknowledges rights for equal use of water, right to use the water area for small constructions as pier or boat shed, and right to use water and ice for domestic use, and the right for travel freely in boundary waters. Timber floating, agreement on which was signed in 1949, is excluded.

Discussions and negotiations over renewal of the agreement have been continuing since 1990's. In 1999 there were two briefings made in Finland to clarify grounds for the renewal of the agreement. In 2002, a report of the Finnish Torne River workgroup was published and delegations were set in both states for negotiations. This resulted into an agreement signed in December 2004. In Finland there were strong opposite views expressed for the governmental bill, and in both states needs for changes were observed. Some renewals were prepared, but there is ongoing debate mainly about fishery issues. A new workgroup was set in Finland with a task to suggest changes in fishery regulations. The workgroup gave their suggestions for changes in 2006.

According gained information (discussions with Hepola M.), there are no further changes in water management issues, but the debate is on fishery questions. Schedule for agreeing upon the last issues as well as signing and ratification are still open (situation in November 2007). Here the contents of the agreement are viewed according the first signed version, excluding the fishery issues.

The new agreement changes the role of the FRC fundamentally. FRC would no longer act as a court or permit authority but application and administrational issues are handled in national bodies. Similar common rights for the use of water and water areas are included. Beyond these rights to use water and water areas, the agreement has been widened to cover preventing damages caused by floods and, more widely, environmental damage, as well as harmonizing the water management plans, programmes and measures while also taking into account the international agreements and community laws.

The assemblage of the FRC is rather similar, but the definitions have somewhat changed. There will still be three members from each state, one representing the state authority responsible for the water issues, one representing the municipalities, one remaining open, with one ore more deputies. Thus, also here the exact demand for legally experienced person has been loosened, congruently with the change of delineation of the agreement.

The common task would be developing cooperation in the river basin district. Separately mentioned tasks are contributing to the cooperation in order to harmonize 1) such programmes, plans and measures that aim at reaching the status objectives in and monitoring the status of the water environment 2) [land use etc.] plans in order to prevent damage caused by floods and other environmental damage. 3) work considering nature conservation plans. The FRC would have the responsibility for common public information and common public hearings for the management plans and programmes. Finally, the FRC would be the explicit organ confirming or rejecting plans or programmes for the river basin district.

The authorities defined for the FRC would be wide in water related issues. It would have the right to give statements and appeal for change in permit matter and, following national legislation, claim for amendment in corresponding authorities for violations of laws, permit decisions or provisions based on law. The FRC could take initiatives and give statements in other [than water management] issues of the river basin district.

Also the geographical area the agreement covers will be changed. The new area is somewhat smaller, following the new delineations for the river basin district. With the new agreement the 2003 note on the international river basin district and also the 1949 agreement on timber floating would be struck down.

4.2 WFD and coordination of IRBD

WFD specifies (Article 3, subsections 3 and 4) that international river basin districts shall be formed by Member States and that these can be coordinated by existing structures stemming from international agreements. In Torne RBD, the Frontier Rivers Agreement between Finland and Sweden provides such a structure in the form of Frontier Rivers Commission. The Frontier Rivers Agreement is currently under revision, and the commission stays in force according the authorization defined in the earlier agreement.

The role of the commission in river basin planning and in relation to the competent authorities cooperation remains to be specified. In the draft agreement the commission would mainly facilitate cooperation between the two nations but also have the power for accepting or rejecting the proposed programmes and plans. Therefore, it seems that the commission might take several positions in relation to the competent authorities.

Lapland Regional Environment Centre is the competent authority governing the Finnish area of the River Torne international river basin (see also chapter 2.3). This means that the responsibilities for river basin planning of the WFD, including risk assessments, water monitoring and setting programme of measures, fall under the activities of the Lapland Regional Environment Centre on the Finnish side. On the Swedish side the competent authority is the Water Authority situated under County Administrative Board of Norrbotten, and the unit of governance is the Bothnian Bay River Basin District.

The Torne River catchment area has been specified as a separate RBD in Finland, while the Swedish delineation of the area, Bothnian Bay RBD, is currently larger, being on regional or county level. The areas of the international river basin of Torne are specified in the draft Frontier Rivers Agreement between Finland and Sweden, so once the agreement has been officially signed the geographical area of the new RBD has been specified also on the Swedish side.

> Water management issue to be addressed: Water Parliament as an interim geographical unit of governance
>
> One of the current administrative problems attached to the water management on Torne RBD is the dissimilar administrative area as the boundary in Sweden covers the county while the Finnish RBD administration has been assigned according to the Torne River catchment. It is therefore possible to use the administrative boundaries of the municipalities that are participating the Water Parliament (see chapter 5.2) at this (interim) stage of administration build-up as the joint area of water management governance on the Swedish side. Other approach is to use the area defined in the draft of the Frontier Rivers Agreement. This would enable more focused geographical cooperation between the water managers and the identified stakeholders within the Torne catchment. It is advisable that the geographical area specified in the draft frontier Rivers Agreement between Finland and Sweden is used for targeting the activities of and participation within the Water Parliament.

More generally, the past years of WFD implementation have lead into differing terminological specifications, interpretations and classification systems (water body typologies) of WFD in different Member States. As already shown with some examples, the Swedish and Finnish implementation approaches have revealed dissimilarities as the first river basin management plans are prepared. It is also probable that the coordination or harmonization requirements arising from nationally different approaches and interpretations of WFD between Finland and Sweden require increased cooperation between competent authorities and national level consideration from the Ministries of Environment and national agencies of WFD implementation (including Swedish EPA and SYKE, FGFRI, Swedish Board of Fisheries).

> Water management issue to be addressed: National cooperation and shared quality elements
>
> On national level it is recommended that interaction between competent authorities, responsible Ministries and the nationally implementing agencies of WFD is increased in 2008-2010 in order to seek official agreement on the adaptation or joint activities of water management in River Torne. These are required also for ensuring harmonized reporting of WFD and common interpretation of river basin planning between Finland and Sweden.
>
> One of the issues to be agreed on is the appropriate level and practice of reporting. Is it feasible to produce separate national reports *and* a joint report for River Torne (three reports) or would River Torne need special attention as part of national reports (e.g. adapted reporting in which Swedish and Finnish implementation would be combined)? For avoiding double reporting, it is recommended that the Torne RBD will be included in the national reports in a similar form both in Finland and in Sweden. This would be a well suited task for the FRC in the future.
>
> The level of detail for the harmonization is likely to require national level cooperation and Ministerial level decisions. National agencies could provide cooperation in the form of joint meetings or by conducting more focused tasks aimed at seeking common ground for e.g. Programme of Measures. The cooperation could also include joint workshops

aimed specifically at harmonizing planning in Torne. National cooperation would also enable agreements of division of tasks between the nations and on the proposed adaptation of water management in Torne RBD.

<u>Water management issue to be addressed</u>: Role of Frontier Rivers Commission in WFD

Applying the Frontier Rivers Commission for harmonizing water management in River Torne within the jurisdiction of the commission is one recommendable point for official interaction in the Torne catchment area. This is also acknowledged in the draft agreement

Below are four proposals for the possible role of the Frontier Rivers Commission in relation to water management in Torne catchment, classified by different scales of official interaction between commission and the competent authorities.

1. Minimum cooperation

The Frontier Rivers Commission takes a role mainly in awareness rising amongst the public in Torne RBD. The activities include disseminating information material, news and possibly presenting the renewed water management and how it is adapted to River Torne. This role would bring the commission closer to the public and present it in a rather neutral position. The commission would not require the maximum capacity (of 6 + 6 members by nation including 3 + 3 experts) for such a task.

2. Intermediate cooperation

The commission participates directly in river basin planning in Torne RBD. In such a role, at least one commission member by nationality (i.e. one Finnish and one Swedish) could act as an official representative in water management cooperation and focus groups composed of stakeholders.

The commission representative(s) could participate in water management stakeholder group(s) on each side of the border and provide joint solutions together with the competent authorities for addressing the problems and issues raised in public participation. This role would include a variety of activities ranging from interpreting and disseminating water monitoring information to designating programmes of measures. This position would place the commission in between stakeholders and competent authorities associating the commission more towards competent authorities.

In intermediate cooperation role, the commission could provide preparatory tasks for the Water Parliament or organize meetings together with the Water Parliament. The variety of tasks in which the commission could participate would influence the required number of active members and experts. Three to four members (including 1-2 experts) per nationality could be justified for taking a more active role in river basin planning.

3. Maximum cooperation

Equal numbers of commission member(s) by nationality are included into competent authorities' coordination group(s) of the RBD in both the Finnish and Swedish side of the jurisdiction. This would position the commission members amongst water managers and include the commission into national and regional level water management planning. For ensuring maximum impact in harmonization and planning, the commission could have up to five or six members (including 2-3 experts) per nationality.

The experts would have an active role working together with Finnish and Swedish competent authorities and their experts. It is also recommendable that the commission is provided yearly funding directed directly towards Torne River water management activities and research and development projects. Sufficient funding of regional water management activities and development projects, together with the proposed 10 commission members, would lay heavy emphasis on the arctic and northern European water management that could be advantageous for the Torne Rive area on both sides of the border.

Increasing resources associated with the Rivers Commission could be advantageous also nationally. In Finland, Lapland Regional Environment Centre is in charge of three RBDs while other competent authorities may have only partial responsibilities of one RBD.

It is therefore recommended, that this option be explored fully when defining the role and the tasks of the Commission. In this role, the commission would make use of the Water Parliament as a cooperation group or focus group, that would participate in specifying the required water management issues e.g. in a similar manner than the cooperation group in Finnish water management.

4. Commission as a competent authority

The commission might also take the responsibility of a competent authority. This would introduce a new body and structure for water management parallel to the Regional Environment Centre (Finland) and County Administrative Board of Norrbotten.

The difficulties of this possibility are connected with the current maximum number of commission members, existing legislation and established competent authorities. The current maximum number of commission members (6 members + 6 experts by nation) seem insufficient for organizing public participation and the other water management tasks arising from WFD, which would introduce requirements for increasing the commission personnel either directly or indirectly. In practice, some tasks are likely to remain within the current competent authorities. In addition, the relation and the powers of the Commission, in reference to the existing competent authorities and water management legislation, would need to be redefined by renewing legislation.

<u>Water management issue to be addressed</u>: Norwegian participation in Torne

Currently Norwegian representation and participation in river basin planning is missing from the Torne RBD although small catchments of Torne are located at the Norwegian side of the border.

It is therefore recommended, that the Water Parliament be considered as a platform for initiating Norwegian participation. At this stage, in which the tasks of the Parliament have not been formed, the Norwegian municipalities / authorities could be included either directly as an equal partner or as an unofficial observer partners.

Within the activities of the River Commission, expert members could act as the connecting agent between the Commission and the Norwegian catchment areas i.e. by visiting the Norwegian authorities and/or stakeholders. Such meetings could be organized more officially via the Water Parliament once its role has been defined and decided. The current character of the Water Parliament, functioning as a stakeholder group, would be well suited for initiating Norwegian participation.

Although the role of the FRC in relation to the established competent authorities remains to be defined in practice, it is recommended that the commission interact in the river basin planning between Sweden and Finland by including its members to the activities of the competent authorities. There is also a possibility for including an amendment specifying the official cooperation in water management via the Frontier Rivers Commission in the draft Frontier Rivers Agreement. At this stage, the Water Parliament would offer a well-suited platform for initiating the cooperation with the Norwegian stakeholders and Norwegian competent authorities.

5. Other approaches and methods for management and participation

5.1

Techniques and methods for management

As a response to the growing global and European political interest in sustaining water resources and corresponding need for improved water resource management, there has been many useful tools - methods and techniques - developed and proposed in later years. In the EU, a number of pilot projects with varying water approaches have been carried out in response to the WFD. New knowledge of practical value has no doubt been generated through these efforts. However, it is not possible in this context to make a comprehensive survey of possible useful ideas and methods in the Torne area, but some interesting examples are mentioned.

The methods and techniques - the tools - in the daily work of the water manager are in this context grouped according to different tasks in the management cycle – a classification in three categories according to how the method relates to the time dimension. The categories are: Describe past and present, Describe future and Evaluate and prescribe.

Describe past and present

Many different tools, techniques and methods are used for descriptive tasks in water management, from plain words to tables and matrices to computer modelling systems. They usually are introduced from an academic discipline. Geographic Information Systems (GIS) is computer software that nowadays is used as a basic tool for storing and organizing the huge amounts of spatial data. Computer programmes based on GIS data provide important opportunities and constraints for daily work in water management. Only the mere amount of data makes this tool indispensable.

Many commercial systems are available on the market, containing a more or less full range of these and other functionalities for water management work. Market leader is ESRI with products like ArcGIS, ARCView, etc. There are also low-budget solutions to satisfy this need. RiverLifeGIS is a software system that can be downloaded to the user's computer. It offers the possibility to analyse different GIS data and visualize results as maps without expensive commercial software (Lauri & Virtanen, 2002, Rintala *et al*. 2007).

A major problem in integrated water management work is that old existing data often are stored in different formats in different databases, etc. Usually many different organizations have been involved in water related work over time. It is costly and time consuming to integrate this data into fewer or even one set that could be used more efficiently in practical work. There is also often a strong need of data integration and coordination of data flows that can efficiently generate new databases. In Germany a system called NOKIS has been developed for storing and exchanging mainly coastal data based on ISO 19115 standards (Reimers *et al*. 2007). It also contains a customized planning tool. The system bridges the information gap between academic disciplines/ sector views such as coastal engineering and ecology, thus enabling information sharing both horizontally and vertically. The system is applied in Federal and State institutions with coastal and WFD responsibilities.

Describe future

Most practical forecasting is made with simple and non-sophisticated more or less intuitive methods. In the new integrated water management, there is a need for more sophisticated techniques. A range of such scientifically based methods and techniques are available. A couple of examples are mentioned here.

The REGCEL model is developed by the Finnish Environmental Institute (SYKE) (Hellsten *et al*. 2002) and can be used for forecasting and assessing effects and impacts of water level fluctuation in regulated lakes. The results can for example be applied to support the designation process of heavily modified water bodies.

The DHRAM water flow analysis method is developed by Black *et al*. (2000). This method is used for assessing alterations in river hydrology.

Evaluate and prescribe

The normal method for most of us of evaluating data/information and make decisions/conclusions is of course qualitative and intuitive. The more complex the problem and the more data and information that are used, the stronger the need is for some kind of decision support method. Modern integrated water management work is a good example where such needs often arise. During later years, a large number of such methods and techniques have been developed and used in a water management context. Some examples, with references for the interested are mentioned below.

• MCDA - Web-HIPRE	Kliucininkas & Martuzevecius. In: Ulvi *et al*, 2007
• Priority Game generator	Hansen & Kristianssen, 2006
• Euro-limpacs	Horlitz *et al*. In: Ulvi *et al*, 2007
• Cost-effectiveness analysis	Mewes. In: Ulvi *et al*, 2007
• Risk assessment	Vuori. In: Ulvi *et al*, 2007.
• MOSDEW	Printz, Schwartz-v.Raumer & Weller. In: Ulvi *et al*, 2007
• Waterwise	van Walsum & Siderius. In: Ulvi *et al*, 2007

It is not possible to analyze and compare the pros and cons of these methods here. Anyone interested needs to take a closer look to find out what can be useful.

Information and communication tools

Water management according to the WFD is a complex activity that requires handling large amounts of information and data. An efficient sharing of data, information and knowledge as well as supporting and enhancing communication between stakeholders are the keys to a successful water management system. There are many tools and methods for this purpose. Examples are focus groups, citizen's juries, public hearings and round table conferences as well as role-playing games and (re)framing workshops. Internet portals and home pages offer many opportunities, and are used more and more. Paper maps, GIS systems and simulation models for instance can also of course support the storage, analysis and sharing of information between stakeholders and therefore contribute to create a common knowledge base etc.

5.2
Participation

The WFD expresses a new and higher level of ambition regarding participation and democracy than earlier comparable legislation. The stakeholders should not only be consulted formally on the products/documents during the continuous planning cycle, but should also be actually actively stimulated to participate in the process.

The background is the present increasing complexity and uncertainty of societal problem (e. g. environmental problems such as water quality) and increasing difficulty of governance and "control" (Giddens 1990, Castells 1997). Socio-economic boundary and frame conditions change quickly and require more flexible management methods. The environmental problems that society faces today are becoming more and more difficult and need new approaches to problem solving. Climate change, with more extreme events, is an example of this.

Classic participation alone is therefore no longer efficient enough, but new methods of "practical daily democracy" are needed. These new methods should replace the traditional hierarchical systems, oriented to control, by more participatory and flexible systems, based on experimenting and social learning between multiple sectors (Wolters *et al*. 2006). The emphasis here is on collaboration rather than merely public consultation. This approach can be described by the concept "Social learning". The concept is about creating trust, promoting relations and networks, about collective learning and eventually collective action. Social learning emphasizes collaboration between the different stakeholders, starting at the earliest possible moment. It helps to build up trust, develop a common view on the water issues at stake, resolve conflicts and arrive at joint solutions that are technically and economically sound and therefore actually more likely to be implemented in practice (Wolters *et al*. 2006). See also table 8 for the benefits of the social learning compared to the traditional consultation.

A social learning process comprises the following aspects (Wolters *et al*. 2006):

1. Learning about each other's opinions and viewpoints;
2. Respect of these opinions and viewpoints, based on an understanding of the underlying reasons;
3. Generating, preserving and exchanging knowledge during the project and for follow-up activities;
4. Enabling stakeholders to adjust their views and attitudes by looking at problems from their neighbours perspective;
5. Changing the management style from bargaining to problem-solving by integrating different interest;
6. Recognition of all stakeholders of the fact that they can learn from each other.

Table 8. Contributions of social learning compared to traditional consultation in water management. The numbers 1 to 6 refer to the list of important aspects in the text. According Wolters et al. 2006.

Participation aiming at mere consultation	Participation aiming at Social Learning	Contribution of Social Learning to water management
1. Participants are motivated to express their expectations concerning participation and their opinions about the issue at stake	1. Participants are encouraged to explain why they have a certain opinion about the issue at stake and what it may mean for them on a personal level, beyond economic aspects	Not only hydrological and ecological factors are discussed but also economical and societal as well as their connectivity
2. People try to convince others to share their individual opinions	2. Participants try to listen and better understand why others do not share their opinions	People learn more about the complexity and inter-linkages of water management.
3. Knowledge gained is limited to the predefined objective of participation. Reports, minutes and other results are made available to stakeholders that participated in the process, and sometimes to the wider public also. The process leads to an exchange of individual knowledge.	3. Knowledge elicitation is highly promoted and goes beyond the predefined objective of the participation process. The issue at stake and the objective remain more open throughout the process. The process leads to a co production of knowledge. Results of the process are prepared to meet the needs of different stakeholders, the public, or whichever target group is defined.	More knowledge about rivers and river basin management is generated. A better focused documentation on different information users increases access to and use of information.
4. Trying to share one opinion.	4. Trying to agree on a consensus without losing the diversity of interests and knowledge	The risk of dropouts during the process and the development of strong opposition are reduced.
5. To reach a decision, the participants bargain. Parties see each other as competitors and their interests as contradictory.	5. From the beginning the process is open to identifying similarities and common interests instead of focusing on differences. It leads to collective action.	More innovative and adapted decisions, a wider sense of ownership of the decisions, commitment to the decisions and better implementation.
6. Rarely achieved	6. Willingness to invest in future process because of individual knowledge gains and more and better relations among stakeholders	Future participatory processes are supported by existing relationships among stakeholders. Changes in understanding and redefining of problems lead to a more sustainable change in practise.

In water management and planning Social learning processes take time and resources in the earlier stages, but are justified because of benefits in the later stages of the 6-year water cycle, meaning the planning and implementation stages. However, actual practical evidence of these benefits is scarce. The HarmoniCOP project (Wolters *et al*. 2006) made a literature review and nine case studies. Their conclusions for participation in WFD work are summarized in table 9.

Table 9. Considerations and recommendations for participation from HarmoniCOP. Wolters *et al.* 2006

Issues	**Considerations**	**Recommendations**
Guidelines	Need for additional guidelines for the implementation of the participatory provisions of the WFD.	These guidelines need to specifically target: - 'Active' involvement methods to help facilitate Social Learning amongst participants. - Informal participation, which actually defines much of the participatory experiences in Europe. - The complex terminology used in the WFD; where possible avoid it altogether in order to make the WFD understandable for non-professionals. - The facilitation of a beneficial attitude through positive interactions. - Ways to learn from crises and to see them as an opportunity to prepare better for the next experience.
Information flow	Poor communication, collaboration and knowledge sharing can stifle the progress of a participatory process or even prevent its initiation. WFD implementation is dependent upon collaboration and communication between regions and sectors.	- Make sure a communication strategy is prepared for working with stakeholders. - Different water sectors need to collaborate and share responsibilities of the different water use sectors. There need to be efforts for better inter-agency communication and collaboration. - More formal agreements for communication and interaction between different scales of intervention. - Creating alliances between existing and new stakeholders. - Provision of information to the wider public of past, current and planned activities and experiences. - Incorporate ongoing monitoring and feedback mechanisms of all participatory activities so to better understand and meet the expectations of the stakeholders involved throughout the process. - Investigate the potential use of IC Tools and apply them in a transparent way that is meaningful for the stakeholders.
Stakeholder ownership and involvement	If ownership of WFD implementation is not widened nationally and regionally, this can result in targets not being reached. Late involvement of stakeholders can cause rejection of plans. The WFD requires active and dynamic forms of participation that are highly resource dependent.	- Need to extend ownership of WFD implementation to a wider group of stakeholders. Responsibility should not remain in the hands of one administrative organisation. - All stakeholders - including citizens - should be involved from the initial stages of the project – right from its very inception, during the development of the plans. This can result in greater ownership of the process, widen responsibility and ensure that the project is properly implemented and not rejected. - Build teams to build resilience and capacity around key people, facilitators and leaders. - To encourage Social Learning, participatory processes need to facilitate greater interaction between the stakeholders. Such process es depend upon resources such as officer time, training, facilitation skills, communication skills, etc. Sufficient resources needs should be accounted for in the project planning and budgeting. - The use of IC tools should be explored and applied to boost quantity and quality of stakeholder involvement and to facilitate Social Learning. The usability of these tools depend upon the availability of time, money and expertise. - Involve key stakeholders in bottom-up planning.

Issues	Considerations	Recommendations
Political and institutional recognition of public participation	Whether the participatory requirements of the WFD implementation are met depends to a large extent on institutional and political recognition of participatory processes. Lack of value given to participatory processes by those at a senior level can also prevent effective implementation.	- There is still much need for national politics to support participatory processes. This can have a positive impact on resourcing participatory initiatives and on the water manager's resolve to undertake a participatory process. It is necessary for institutions to adopt a culture towards greater stakeholder involvement so that participatory processes are practiced more widely in sectors other than in water. Political structure may support this culture. - Existing policy efforts that already support participatory processes should be built upon and extended. - Senior level officers of governing bodies and water authorities responsible for the overall implementation of the WFD should support stakeholder involvement. This is required to give the water managers the authority to involve stakeholders at the early planning stages, to stimulate Social Learning and to identify common ground in the decision-making processes.

In the Torne River area, the conclusion therefore is that it is important to develop participatory processes more according to modern social learning principles, thereby creating a more open, flexible and adaptive water management style than earlier. This calls for changes in concepts, methods, techniques, etc. also perhaps organisational changes, and somewhat different roles for government actors. Many ideas and practical advices for future work along these lines can be found in the above tables.

Participation in Torne River area

As described earlier, in Finnish and Swedish national legislation on water management, the participation procedure has been left pretty open beyond the obligatory working/reference groups and the six-month public hearing periods. In Finland, also a specified subgroup for heavily modified waters has been in action and some, although mild discussion on regional subgroups has been arising. In Sweden, work for arranging regional work in form of Water Councils (Vattenråd) is ongoing.

In this project, we screened out how the authorities, actors and people of the region feel about the possibilities and need for wider cooperation across the border in water management. First, we arranged a meeting, Torne River Water Parliament, in cooperation with the Torne Valley Council and a Swedish project, 'Vattensamverkan Norr'. Secondly, we run an internet survey to get a wider picture of the situation.

Torne River Water Parliament

In May 2007, regional authorities, municipalities, actors, organizations and associations were invited to a meeting to discuss the water management issues. Invitation was sent to some 70 parties from Sweden and Finland, with a wish to spread the information to other possible parties involved. The invitation was also sent to Norwegian parties. The parliament had 40 participants.

An overall picture was that a common cooperation is needed for the water management work. It became clear that local people felt that the Frontier Rivers Commission (FRC) has been a good decisive organ in the region and they have fears of not being heard if the decisions on water permits are taken further away. Suggestions were that FRC would be the cooperative organ. As a permit authority, the FRC cannot participate strongly in discussions, but with the renewal of the agreement, the role will change. That will take time, and discussion forum is needed even before that – on the other hand, if some common structure is developed, it can be used despite which organ is officially responsible for the joint work. In addition, existing organizations were suggested to work as a cooperative organ. There could however be some possibility for people connecting the work too much with the specific organization, and it was felt that it is better to keep this kind of common work and discussion forum independent.

It was suggested that a meeting, called Water Parliament or parallel, could be arranged once or twice a year to discuss common issues and give suggestions. Participation would be open for all interested. In addition, it was suggested that the parliament would have a smaller work group that could work more actively with the authorities preparing the management plans. Locally, and subject vice, there could be other structures according to people's wishes and needs: it was suggested that the municipalities could take more responsibility for the cooperation in their area.

Internet survey

In late June – September 2007 an internet survey was published. The survey was both in Finnish and Swedish, and it was available at the LAPREC and CAN web pages. Many of the municipalities of Torne River area had also linked it to their home page. Also newspapers, e-mail and other contacts were used to spread information of the survey. The work report with more detailed results is available at www.triwa.org (Käki 2008).

The survey included questions on people's opinion about and wishes for cooperation and participation in water management. In addition, availability of information and the common view of the status of the aquatic environment were mapped. Here main lines of the results are presented.

There were altogether 272 answers for the survey, 33 % of which were Finnish, 66 % Swedish and 1 % of other nationalities. Majority, 63 %, was inhabitants of the area, second biggest group being summer guests (14 %). 60 % of the answerers were 39-60 years old. Opinions about different issues followed similar lines despite the nationality, only in some issues there were apparent differences.

Almost 80 % of the people felt they did not get enough information on water management issues, and approximately 55 % (Table 10) felt that their possibilities to influence decision-making were poor or very poor. People felt that they were either not heard, or if they were heard, their opinions were not taken into account (Table 11). This was a common view, even though slightly stronger among the Swedish participants. Nevertheless, 42 % of the Finnish and 35 % of the Swedish felt that the possibilities to influence decisions are at least fair.

Table 10. Opinion about the possibilities to influence decisions (n=258).

	Finnish	Swedish %	Together
Very good	0,0	2,3	1,6
Good	6,2	5,1	5,4
Fair	42,0	35,0	37,2
Bad	42,0	28,2	32,6
Very bad	9,9	29,4	23,3

Table 11. Opinion about the possibilities to participate in decision making (n=246).

	Finnish	Swedish %	Together
The decisions are done without hearing the inhabitants	21,3	32,2	28,9
The inhabitants are heard but their opinions are not taken into account	54,7	49,1	50,8
The decisions are based on the proposals of the inhabitants and the authorities	24,0	14,0	17,1
The decisions are based on the proposals of the inhabitants	0,0	4,7	3,3

People do want to participate in decision-making. Of the preferred ways, the Finnish and Swedish had slightly different views (Fig. 6). Swedish preferred village meetings compared to Finnish participants, and for the Finnish, public hearings were more preferable that to the Swedish. Communal meetings, village meetings and public hearings were all quite accepted. Internet was the most popular form of participation, 40-48 % preferring it. This is probably at least partly due to the fact that the survey was made by internet, thus the participants find it easy to use. Associations, organisations and regional meetings were not very popular.

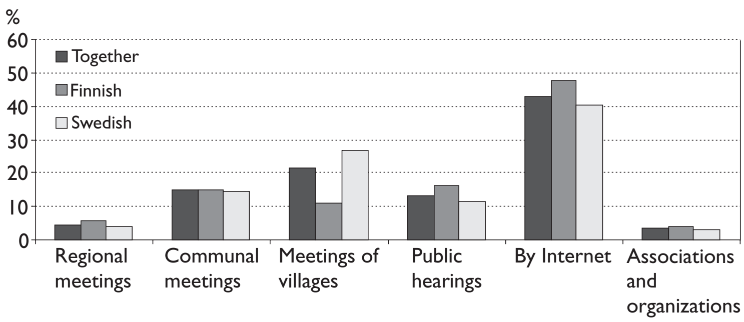


Fig. 6. Preference of means of participation.

The common view is that the waters in Torne River watershed are mostly in natural or nearly natural state. Swedish have this view more strongly, emphasizing natural (32 %) or nearly natural (56 %) against the Finnish views (9 % - 41 %). The Finnish found the water environment more often either slightly altered or eutrophicated (50 %) than the Swedish (12 %). Water problems were recognized on both sides: abundant vegetation and turbid water were the most commonly seen problems, abundance of algae, sliminess or bad smell of water being common, too. From the possible causes behind the impacts, forestry, agriculture and loading from communities were considered the strongest. The Finnish weighted highest the agriculture, the Swedish the forestry.

Conclusions

It is obvious that participatory processes need developing in both Finland and Sweden. In Finland, the opinions of the authorities implementing water management planning, and members of joint working groups representing NGOs were screened in a study made in 2007 (Laurinolli 2007), and this need was revealed also there. Even though, in principle, every one has possibility to participate, mere possibility is not sufficient for genuine interaction. Traditional forms of public hearings are not sufficient for this, and for example, processes used in environmental impact assessment can be useful.

Water management does not involve just one type of action (as for example one factory or one peat mining plant) but larger areas with all activities included, and we are discussing issues that can have impact for decades. This can on the one hand attract, on the other hand make it difficult to comprehend, as the results are not necessarily seen in short term. In addition, if there are no obvious, striking problems, as it is the case in many areas in Torne River area, it is also more difficult to get people interested in the work. Participation is voluntary and can be fruitful only if people feel it is worth the effort. Need for activation does not include only the inhabitants of the area but all stakeholders and authorities of different level to see the benefits of the process.

It is clear that both the Finnish and the Swedish wish more cooperation in the water issues. Water Parliament or a parallel organ with low bureaucracy seems as a possible solution for one level of cooperation. Further, smaller regional, or local meetings are recommended depending on the issues and needs. In Torne River area, where distances are long and partially the population is very scattered, the need for resources is highlighted. Especially here, also possibilities for internet-based participation – discussion groups, net meetings, surveys etc. - are worth developing. For all these choices, reasonable resources should be secured, as it is obvious that with the current ones it is not possible to forward in this area. Resources should be directed both to authorities and to NGO's for this specific purpose.

6. Discussion

A number of factors are important for developing and improving water management in the International District of the Torne River area. Some of the relevant factors are: legislation, administrative procedures/practices in for instance public participation, organisational structures and economic resources, the use of methods and techniques for water classification etc, water monitoring strategies and data handling issues.

Relevant legislation in Finland and Sweden should be further harmonized in order to facilitate the joint water management work. It is not possible to specify here in detail all the necessary changes, on the one hand because many of the handicaps are revealed only in the practical work and, on the other hand because national guidance for the implementation has not been ready so far during this process. It is clear that the changes have to be made stepwise, gradually and from a joint common perspective. This is naturally not simple since two independent states are involved. Legislative changes can be made in both or one of the countries.

Administrative procedures and practices are often specified in the legislation or some ordinance, etc. One very fundamental factor that the two countries need to coordinate is the timetable of the work. A common master time plan for the water management work in Torne river valley is therefore necessary. At present, the Finnish time plan defined in the administrational decisions is 6 months (3 months in 2007) ahead of the Swedish. This in reality makes all types of coordinating work more difficult or even impossible. To create a management plan for the Torne river district will be virtually impossible in practice if this issue is not resolved.

Organisational structures are an important, though less critical factor. The required results, procedures and products of the WFD can be applied in many different organisational structures. The present organisation, therefore, can probably work well. The new Frontier Rivers Agreement is a common legislation that, since its implementation has been delayed, means that one important actor in the organisational structure is not yet in place. This has also delayed the progress in some parts of the water management work cross the border area.

Economic resources are always important when discussing results and efficiency of this type of work. The fact that LAPREC has significantly less resources and people for the water management work than CAN is therefore a problem for the joint work towards a common goal in Torne river area. It is therefore important for the water management work that also economic resources are more harmonized than at present. In the future, also the Frontier Rivers Commission has to be empowered by ensuring sufficient resources, both personnel and operational funding.

Methods and techniques used in many forms of water management work are in rapid development and need to be analyzed, adjusted, etc., so that the work efficiency and quality of the numerous products prepared during the six-year cycle are as high as possible. This should be made in cooperation between the countries so that consequences and impacts on work result etc. are carefully considered. A number of ideas and proposals are presented on the subject in this report, but the practical work will finally give more ideas of where to go.

In this project, suggestion for common typology and nationally suggested classifications have been tested for some possible evaluation tools. However, current legislation does not allow them to be used directly in the region on Finnish side, which leads to multiple work and results that can confuse parties involved. This is not a bearable situation and has to be resolved.

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Part II

Ecological indicators

A. Fish communities

Fish communities of 15 lakes in River Torne basin: aspects of lake typology and ecological status

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CONTENTS

1. Introduction

The River Torne watershed is an international River Basin District according to the EU Water Framework Directive (WFD). The WFD requires cross-border cooperation in areas where waters are common for many countries such as River Torne area. One of the objectives of WFD is to achieve good ecological status for all surface waters by 2015. The assessment of ecological status in rivers and lakes is based on chemical and biological factors (phytoplankton, macrophytes, benthic macroinvertebrates and fish) according to the WFD.

The aim of TRIWA I project (The River Torne International Watershed) was to develop a harmonised Finnish-Swedish typology for lakes and rivers in the River Torne watershed. Another aim was to establish reference conditions for the most common water types of the River Torne watershed. Both above-mentioned aims were achieved in TRIWA I project (Elfvendahl et al. 2006). Developed harmonised typology and reference conditions for lakes were based on water chemistry, phytoplankton and benthic macroinvertebrates, but fish fauna was not included because of the lack of resources.

This work is a part of TRIWA II project, in which one aim is to complement the reference conditions with some new biological elements: periphyton (in rivers) and fish (in lakes). Another important aim is to evaluate the usefulness of chosen biological factors for evaluating the ecological status of the aquatic environment in the North.

The aim of this work was to test the developed harmonised preliminary and revised TRIWA lake typologies using fish community data from the reference lakes. Another aim was to evaluate the ecological status of the lakes using both Finnish and Swedish typologies and ecological quality ratios (EQR’s). Aim was also to make comparisons between the preliminary and revised TRIWA typologies and national evaluations of ecological status of the reference lakes. Final aim was to evaluate the usefulness of fish community data for evaluating the ecological status of the aquatic environment in the North.

2. Survey lakes and typology

2.1 Finnish and Swedish typologies

The Finnish typology for lakes has a total of 12 lake types. Lakes are divided into different types by mean depth, lake area and water colour. Typology contains three size-classes (<5 km^2, 5-40 km^2 and >40 km^2) and three colour-classes (<30 mg Pt/l, 30-90 mg Pt/l and >90 mg Pt/l). Lakes are considered shallow if the mean depth is below three meters. Also lakes that have short retention time, are naturally nutrient rich or are located in the highland areas of Lapland are separate lake types.

The main difference in Swedish typology compared to Finnish typology is the ecoregion approach. The Swedish typology has a total of seven ecoregions and 16 lake types in each of them (Naturvårdsverket 2006). Lakes are divided into different types by maximum depth, lake area, water colour and alkalinity. Typology contains two depth-classes (<5 m and >5 m), two size-classes (<10 km^2 and >10 km^2), two colour-classes (<50 mg Pt/l, and >50 mg Pt/l) and two alkalinity-classes (<1,0 mekv alk and >1,0 mekv alk). This results in 48 possible lake types for the River Torne area.

2.2 Preliminary TRIWA typology

The preliminary harmonised TRIWA typology for lakes has a total of 13 lake types. Lakes are divided into different types by ecoregion, lake area and water colour. Preliminary typology contains three groups for ecoregion (mountain, inland and coastal lakes), three size-classes (0,5-2 km^2, 2-10 km^2 and >10 km^2) and two colour-classes (<60 mg Pt/l and >60 mg Pt/l). The lakes that included in the fish community survey were mainly the same as in TRIWA I project where the water chemistry, phytoplankton and benthic macroinvertebrates of the selected lakes were studied excluding mountain lakes (type 1). The requirements for potential reference lakes were limited anthropogenic impact, good water quality and moderately easy accessibility by car. According to the preliminary harmonised TRIWA typology the selected lakes represent 3 lake types from the coastal and inland regions (Table 1). The lake types were small clear-water inland lakes (type 2), small brown-water inland lakes (type 3) and small brown-water coastal lakes (type 9). Lake Nuuksujärvi was not included in the typologies because there were no water chemistry data available.

2.3

Revised TRIWA typology

The results of the earlier survey (Elfvendahl et al. 2006) showed that biological elements did not support the ecoregion based grouping of the preliminary harmonised typology. This led to the revised harmonised typology where inland and coastal lake types were combined to southern lowland lake types. The revised harmonised typology for lakes has a total of 7 lake types. Revised typology contains two groups for ecoregion (northern highland and southern lowland lakes), three size-classes (0,5-2 km^2, 2-10 km^2 and >10 km^2) and two colour-classes (<60 mg Pt/l and >60 mg Pt/l). According to the revised harmonised TRIWA typology the selected lakes represent 2 lake types from the southern lowland region (Table 2). The lake types were small clear-water lowland lakes (type 2) and small brown-water lowland lakes (type 3).

Table 1. Characteristics of the surveyed lakes by preliminary TRIWA lake types. Water quality parameters represent the seasonal means of surface water from 2004.

LAKE	ALTITUDE (m.a.s.l)	AREA (ha)	MAX DEPTH (m)	pH	COLOUR (mg Pt/l)	P-tot (µg/l)	N-tot (µg/l)
Type 2							
Isolompolo (Fi)	233	54,4	2,0	6,95	50	12	284
Keimiöjärvi (Fi)	333	60,8	7,8	6,97	38	14	232
Olosjärvi (Fi)	242	191,8	13,7	6,98	42	13	298
Suolajärvi (Swe)	316	70,6	8,0	7,18	20	17	314
Valkeajärvi (Swe)	315	62,0	11,0	7,22	13	6	255
Type 3							
Kitkiöjärvi (Swe)	255	156,3	15,0	6,72	67	13	278
Nivunkijärvi (Fi)	298	144,2	2,0	6,90	63	14	338
Nulusjärvi (Fi)	231	81,6	2,0	6,95	77	16	350
Oustajärvi (Fi)	235	53,0	2,0	6,66	105	15	380
Pääjärvi (Swe)	189	92,0	3,9	6,89	67	33	638
Type 9							
Liehittäjäjärvi (Swe)	132	107,6	6,3	6,74	101	16	370
Merijärvi (Fi)	85	113,8	5,8	6,91	115	21	472
Pirttijärvi (Swe)	141	142,4	6,2	6,73	133	24	514
Puolamajärvi (Fi)	91	164,2	8,8	7,11	44	11	282

Table 2. Characteristics of the surveyed lakes by revised TRIWA lake types. Water quality parameters represent the seasonal means of surface water from 2004.

LAKE	ALTITUDE (m.a.s.l)	AREA (ha)	MAX DEPTH (m)	pH	COLOUR (mg Pt/l)	P-tot (µg/l)	N-tot (µg/l)
Type 2							
Isolompolo (Fi)	233	54,4	2,0	6,95	50	12	284
Keimiöjärvi (Fi)	333	60,8	7,8	6,97	38	14	232
Olosjärvi (Fi)	242	191,8	13,7	6,98	42	13	298
Puolamajärvi (Fi)	91	164,2	8,8	7,11	44	11	282
Suolajärvi (Swe)	316	70,6	8,0	7,18	20	17	314
Valkeajärvi (Swe)	315	62,0	11,0	7,22	13	6	255
Type 3							
Kitkiöjärvi (Swe)	255	156,3	15,0	6,72	67	13	278
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Pirttijärvi (Swe)	141	142,4	6,2	6,73	133	24	514
Pääjärvi (Swe)	189	92,0	3,9	6,89	67	33	638

3. Material and methods

3.1
Sampling and analysis

Test fishing

The test fishing of the small clear-water (type 2) and brown-water (type 3) lowland lakes was carried out separately in Finland and Sweden. In Finland the fishing was carried out by the Finnish Game and Fisheries Research Institute from august to September 2006. In Sweden the fishing was carried out by the Swedish Board of Fisheries in august 2005 and 2006. NORDIC multimesh survey nets 1,5 x 30 m (Appelberg et al. 1995) were used in the test fishing. NORDIC nets consist of 12 panels (2,5 m each) having mesh sizes 5, 6.25, 8, 10, 12.5, 15.5, 19.5, 24, 29, 35, 43 and 55 mm (Fig. 1). Test fishing was carried out using a stratified random sampling method (Kurkilahti 1999). The survey lakes were divided into depth zones from which the net sites were chosen randomly. Main differences between the national test fishing methods were different boundaries of the depth zones and the use of pelagic nets in Finland. In Finland the lakes were divided into two depth zones, which were 0-3 m and 3-10 m. In the shallowest zone only benthic nets were used whereas in a depth zone 3-10 m pelagic nets were also used. In Sweden the lakes were divided into three depth zones (0-3 m, 3-6 m and >6 m) and only benthic nets were used. In Finland the sampling effort ranged from 12 to 24 net nights and in Sweden from 16 to 24 net nights according to lake area and depth (Table 3 and 4). The nets were set in the evening and they were hauled in the next morning. Every lake in Finland was sampled twice on two non-consecutive dates, when possible, whereas lakes in Sweden were sampled once.

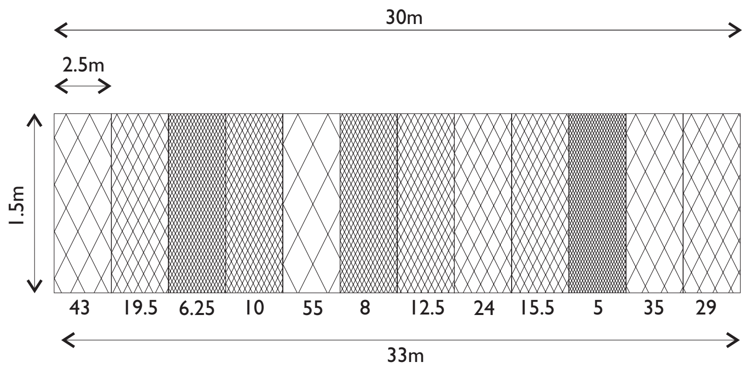


Fig. 1. The construction of the NORDIC multimesh survey net.

Table 3. Survey lakes in Finland 2006 and fishing effort/depth zone according to area and depth.

LAKE	AREA (ha)	MAX DEPTH (m)	NUMBER OF NET NIGHTS/DEPTH ZONE 0-3 m Benthic	3-10 m Pelagic	Benthic	Total
Isolompolo	54,4	2	12	-	-	12
Keimiöjärvi	60,8	7,8	8	4	4	16
Merijärvi	113,8	5,8	8	6	6	20
Nivunkijärvi	144,2	2	16	-	-	16
Nulusjärvi	81,6	2	12	-	-	12
Olosjärvi	191,8	13,7	8	8	8	24
Oustajärvi	53,0	2	12	-	-	12
Puolamajärvi	164,2	8,8	8	8	8	24

Table 4. Survey lakes in Sweden 2005 and 2006, and fishing effort/depth zone according to area and depth.

LAKE	AREA (ha)	MAX DEPTH (m)	NUMBER OF NET NIGHTS/DEPTH ZONE 0-3 m Benthic	3-6 m Benthic	>6 m Benthic	Total
Kitkiöjärvi	156,3	15	8	8	8	24
Liehittäjäjärvi	107,6	6,3	12	10	2	24
Nuuksujärvi	114	8	8	8	-	16
Pirttijärvi	142,4	6,2	20	4	-	24
Pääjärvi	92	3,9	13	3	-	16
Suolajärvi	70,6	8	8	8	8	24
Valkeajärvi	62	11	8	9	7	24

The catch of each net was handled separately and by mesh size. Each catch was sorted by species and then counted and weighed. Total catches, catches of species groups and catches of each fish species were calculated as catch per unit effort (CPUE, g/net and CPUE, number/net). For size distributions, the total length of every fish was measured at 1 cm accuracy. In Finland also the total number and weight of potentially piscivorous perch (*Perca fluviatilis*) (>15 cm) was calculated separately for predatory fishes proportion.

Comparison of typologies

The comparisons between the lake types were done using same fish community variables as in evaluation of ecological status. They were total CPUE's, Simpson's diversity indexes, biomass proportion of cyprinids in the catch, perch/cyprinids biomass ratio, mean weight of fishes, the biomass proportion of potentially predatory percids, number of species and number of sensitive species. Only benthic nets were noticed in calculations. Only cyprinid species that benefit from eutrophication were included in cyprinids proportion variable. These were roach (*Rutilus rutilus*), bleak (*Alburnus alburnus*) and bream (*Abramis brama*). The sensitive species, that indicate conditions of the hypolimnion, benthic quality and conditions of the littoral zone (mainly stony shores), were vendace (*Coregonus albula*), whitefish, brown trout (*Salmo trutta*), burbot (*Lota lota*), bullhead (*Cottus gobio*) and minnow (*Phoxinus phoxinus*). Means and standard deviations were calculated for each variable separately by lake type. Lake Nuuksujärvi was not included in the typologies because there were no water chemistry data available.

Evaluating the ecological status

Ecological quality ratio (EQR) describes the similarity or difference of biological quality elements from reference conditions. Ecological quality ratio can be measured for a single variable or index that constitutes from several variables. The EQR is calculated by dividing the observed value with reference value. The status class can be considered high if the observed value is equal to the reference value.

The ecological status of the reference lakes was evaluated using national ecological quality ratios, which constitutes from several variables. The Finnish EQR4 (Tammi et al. 2006) is based on variables that are sensitive to eutrophication. They were total CPUE's (g/net and number/net), the biomass proportion of cyprinids and indicator species. If no cyprinid fishes were present in a lake then cyprinids proportion variable was not used. Both benthic and pelagic nets were noticed in calculations but EQR values were also calculated separately for benthic nets. First the reference lakes were divided into different lake types according to Finnish national typology. Then the EQR values for each variable from every lake were calculated by dividing the observed values with type specific reference values. EQR values were transformed to the scale 0-1 by multiplying EQR values with a constant. Finally the EQR values of each variable were combined to EQR4 by calculating average from their EQR's. In Finnish EQR4 the class boundaries between the ecological classes are set to equal distances (Table 5).

The Swedish EQR8 (Holmgren et al. 2007) is based on eight different variables. They were the number of species, Simpson's diversity indexes for both number and biomass, total CPUE's (g/net and number/net), mean weight of fishes, the biomass proportion of potentially predatory percids and perch/cyprinids biomass ratio. If no cyprinid fishes were present in a lake then perch/cyprinids biomass ratio variable was not used. Likewise if perch was not present in a lake then predatory percids variable was not used. Only benthic nets were noticed in calculations. The lake-specific reference value for each variable was calculated using equations including one to four environmental factors (altitude, lake area, maximum depth, annual mean in air temperature, and/or location below or above the highest coast line after deglaciation). Intercepts and regression coefficients in the equations were revealed by using data from 116 non-limed lakes with low values in acidity (pH > 6), nutrients (total phosphorous < 20 µg/l) and land use (agriculture < 25 % and built-up area < 1 % of the catchment). The residuals for each variable from every lake were calculated by subtracting reference value from observed value. Next the Z-values were calculated by dividing residuals with variable specific standard deviations (SD). Then the Z-values were transformed to P-values by scaling Z-values to scale 0-1. Finally the P-values of each variable were combined to EQR8 by calculating the average of P-values. The EQR8 class boundaries between the ecological classes are also presented in table 5.

Table 5. The boundaries of ecological status classes according to national EQR's.

EQR4	Status class	EQR8
1,0-0,8	High	1,0-0,72
0,8-0,6	Good	0,72-0,46
0,6-0,4	Moderate	0,46-0,30
0,4-0,2	Poor	0,30-0,15
<0,2	Bad	<0,15

3.2

Statistical methods

The differences in the most important fish community variables between the preliminary lake types (2,3 and 9) were tested with one-way Analysis of Variance (ANOVA). In the case of statistically significant difference ($p < 0.05$) the pair-wise differences were tested using Tukey's test. The differences in fish community variables between the revised lake types (2 and 3) were tested using T-test. In the case of few fish community variables their dependence on the environmental factors was tested using stepwise regression model. All statistical analyses were carried out using the SYSTAT v10.2 software.

4. Fish community structure in the surveyed lakes

4.1

Total CPUE's

The total CPUE's in biomass varied between 751 to 5824 g/net in the surveyed lakes (Fig. 2). Respectively, the total CPUE's in numbers varied between 18 to 236 ind./net. In both cases the highest catches were caught from Lake Nuuksujärvi whereas the lowest biomass catch were caught from Lake Nivunkijärvi and the lowest number catch from Lake Valkeajärvi respectively. There was also a positive correlation between the total CPUE's and lake productivity (Fig. 3). The total CPUE's in biomass and numbers seemed to increase along the total phosphorus gradient. However, that was mainly due to high CPUE's in Lake Nuuksujärvi, which also had the highest total phosphorus concentration. On the other hand in lakes Isolompolo and Keimiöjärvi especially the total CPUE's in biomass were quite high in respect to their low total phosphorus concentration and apparently low trophic status.

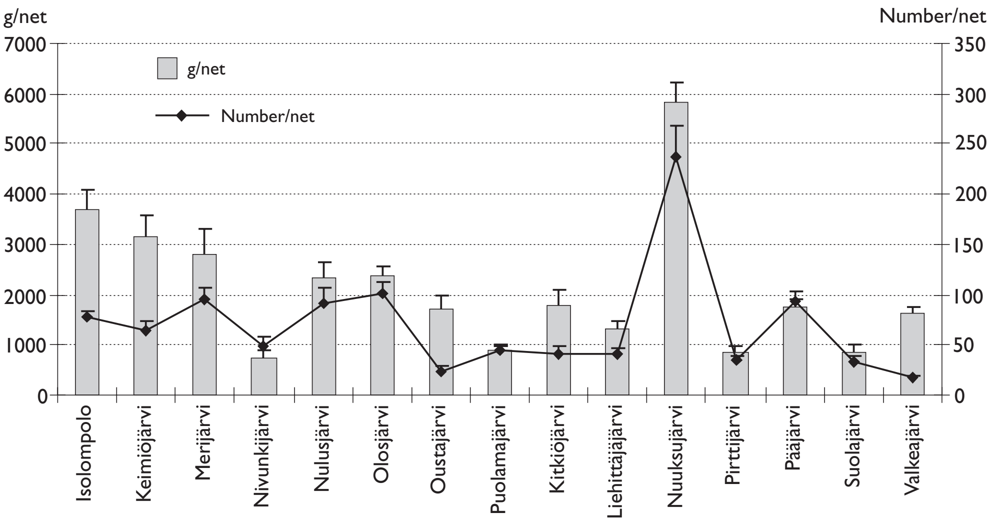


Fig. 2. The total CPUE's in surveyed lakes 2005-2006 and standard errors (s.e).

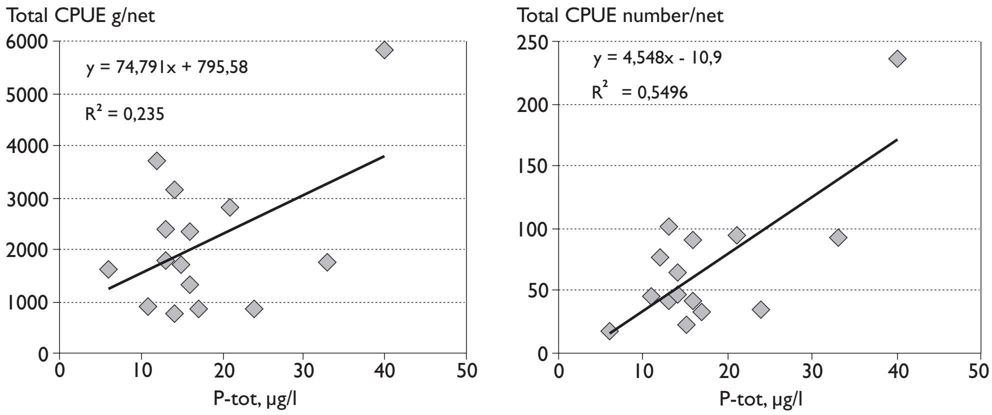


Fig. 3. Correlations between the total CPUE's and lake productivity of the surveyed lakes.

4.2
CPUE's of fish species

Based on test fishing results the species number varied between 1 and 8 in the surveyed lakes (Table 6 and 7). Perch was the most common fish species in the surveyed lakes missing only from Lake Valkeajärvi. Pike (*Esox lucius*) and roach were both present in 11 lakes and ruffe (*Gymnocephalus cernuus*) was present in 8 lakes. Other fish species were not as common as those above-mentioned. According to CPUE's perch and roach were the dominant fish species in biomass catch and number catch. Only clear exception was Lake Valkeajärvi where whitefish was the dominant fish species. The test fishing results are not totally comparable because the national test fishing practices differed from each other. In the case of lakes Keimiöjärvi, Merijärvi, Olosjärvi and Puolamajärvi the total CPUE's would have been generally higher if pelagic nets were not used (Table 8). But because the variation of CPUE's is large the significance of such differences remained minor. Also the biomass proportion of cyprinids in the catches would remain 2 to 5 percent units smaller if only benthic nets were noticed. In the case of lakes Merijärvi and Olosjärvi the CPUE's of pelagic species such as vendace and bleak would remain 25 to 92 % smaller if pelagic nets were not used. However, the influence of using pelagic nets to overall results remained quite small because the proportion of vendace and bleak in the total catches were initially small.

Table 6. The CPUE's (g/net) according to fish species in surveyed lakes 2005-2006.

LAKE	CPUE (g/net) OF FISH SPECIES														
	PERCH	RUFFE	PIKE	VENDACE	WHITEFISH	TROUT	BURBOT	BULLHEAD	MINNOW	DACE	IDE	ROACH	BLEAK	BREAM	TOTAL
Isolompolo	1482,7	2,6	614,3		59,5				0,1			1529,9	15,5		3704,6
Keimiöjärvi	3132,6					17,9	2,7								3153,2
Merijärvi	1546,0	3,8	213,5									301,2	18,0	736,7	2819,1
Nivunkijärvi	750,9														750,9
Nulusjärvi	545,0	6,9	33,2	4,5	5,0					161,2		1480,4	84,4		2320,6
Olosjärvi	746,6	2,4	118,8	10,5	5,8				0,3			1386,0	92,0		2362,3
Oustajärvi	1621,3		74,3												1695,6
Puolamajärvi	268,4	13,8			19,7							595,9			897,8
Kitkiöjärvi	1358,3		60,1	14,2								370,9			1803,5
Liehittäjäjärvi	865,7	2,7	137,1									316,1			1321,6
Nuuksujärvi	2172,9		409,0									3242,0			5823,9
Pirttijärvi	553,7	6,7	68,6									205,8	34,1		868,9
Pääjärvi	575,6		84,4									1093,6			1753,6
Suolajärvi	428,3	87,6	62,5		178,1						11,2	73,4			841,0
Valkeajärvi					1562,6		37,9	0,7	35,5						1636,7

Table 7. The CPUE's (number/net) according to fish species in surveyed lakes 2005-2006.

LAKE	CPUE (number/net) OF FISH SPECIES														
	PERCH	RUFFE	PIKE	VENDACE	WHITEFISH	TROUT	BURBOT	BULLHEAD	MINNOW	DACE	IDE	ROACH	BLEAK	BREAM	TOTAL
Isolompolo	11,1	0,3	0,7		0,3				0,1			63,3	1,4		77,2
Keimiöjärvi	64,3					0,1	0,1								64,5
Merijärvi	72,6	1,3	0,1									15,0	0,9	5,2	94,9
Nivunkijärvi	48,1														48,1
Nulusjärvi	31,4	2,2	0,1	0,4	0,1					2,8		43,2	10,6		90,8
Olosjärvi	12,7	0,5	0,1	1,5	0,2				0,3			73,7	12,2		101,2
Oustajärvi	22,1		0,3												22,4
Puolamajärvi	11,9	1,2			0,0							32,5			45,7
Kitkiöjärvi	26,8		0,1	1,3								13,0			41,2
Liehittäjäjärvi	29,8	1,0	0,3									10,2			41,3
Nuuksujärvi	106,2		0,4									129,7			236,3
Pirttijärvi	19,2	1,8	0,1									11,3	1,8		34,2
Pääjärvi	22,9		0,1									70,6			93,5
Suolajärvi	18,8	11,3	0,0		0,8						0,1	1,8			32,9
Valkeajärvi					8,8		0,5	0,1	8,3						17,6

Table 8. Influence of using pelagic nets to most important fish community variables.

Lake	Total CPUE (g/net)	Total CPUE (number/net)	Mean weight (g)	Cyprinids biomass %	Number of species	Number of sensitive species
Keimiöjärvi						
all nets	3153,2	64,5	48,9	-	3	2
benthic nets	3690,1	75,5	48,9	-	3	2
Merijärvi						
all nets	2819,1	94,9	29,7	37,5	6	-
benthic nets	3385,9	90,4	37,4	35,6	6	-
Olosjärvi						
all nets	2362,3	101,2	23,4	62,6	8	3
benthic nets	2675,4	103,1	25,9	57,7	8	3
Puolamajärvi						
all nets	897,8	45,7	19,7	66,4	4	1
benthic nets	1094,3	53,1	20,6	63,1	3	0

5. Comparison of TRIWA typologies using fish community variables

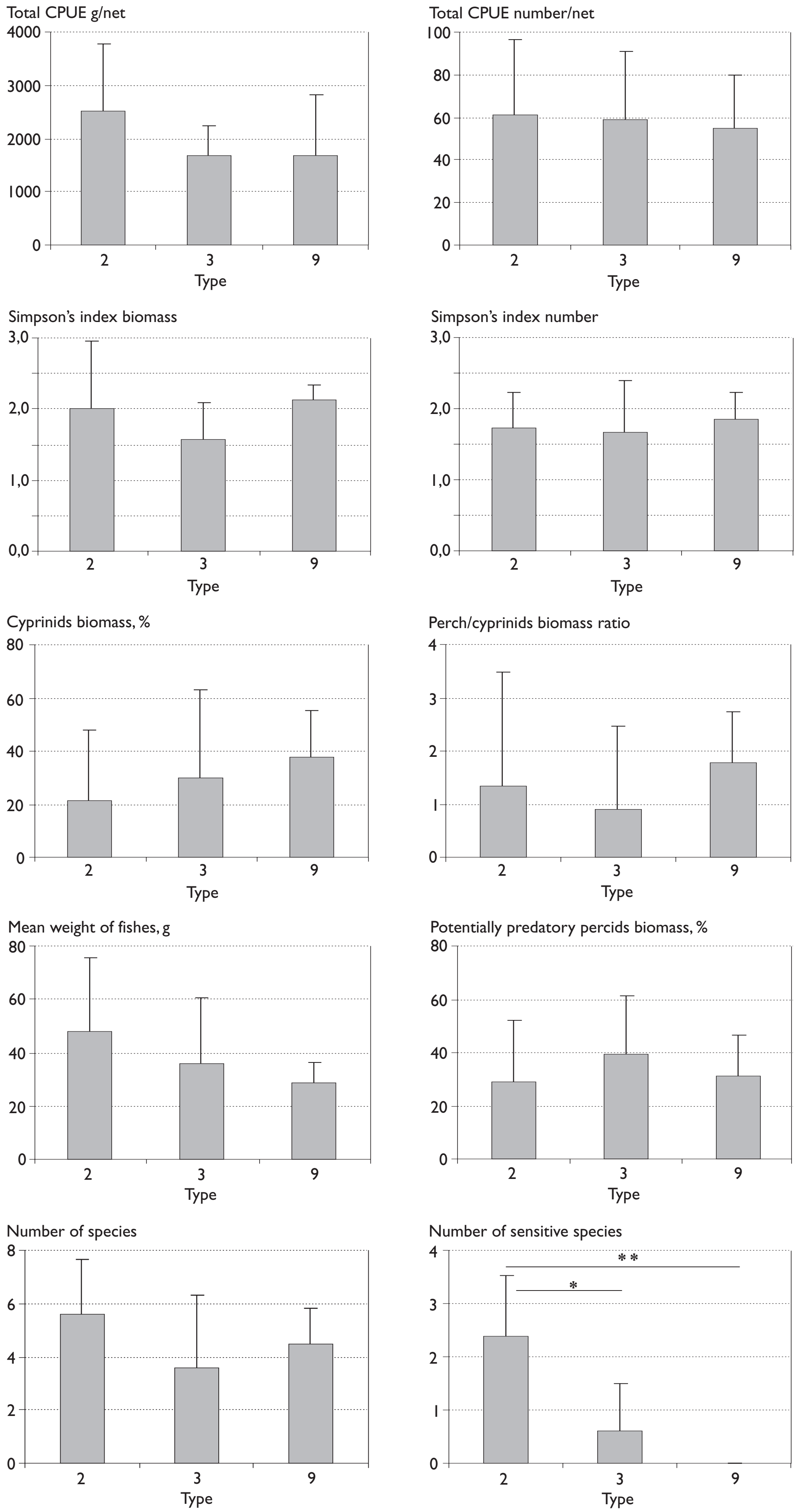
5.1
Testing the preliminary TRIWA typology

Comparison of the preliminary lake types 2, 3 and 9 was done with compiled data using the most important fish community variables. Total CPUE's in biomass were higher in the small clear-water inland lakes (type 2) than in the small brown-water inland (type 3) and coastal lakes (type 9) (Fig. 4). Also the mean weight of fishes in the catch and the number of species was highest in the type 2 lakes, whereas the biomass proportion of cyprinids was highest in the small brown-water coastal lakes. However, the observed differences were not statistically significant due to high variation within the lake types. The only fish community variable that expressed clear between-type differences was the number of sensitive species. The number of sensitive species was highest in the type 2 lakes, which differed statistically from the other lake types.

5.2
Testing the revised TRIWA typology

Comparison of the revised lake types 2 and 3 was done with compiled data using same variables as in the case of preliminary lake types. Total CPUE's in biomass were higher in the small clear-water lakes (type 2) than in the small brown-water lakes (type 3) (Fig. 5). Also the mean weight of fishes in the catch and the number of species was higher in the small clear-water lakes than in the small brown-water lakes. The biomass proportion of potentially predatory percids was higher in the small brown-water lakes. However, the observed differences were not statistically significant due to high variation within the lake types. No differences between the lake types were found in the total CPUE's in number, Simpson's indexes, biomass proportion of cyprinids or perch/cyprinids biomass ratio. The only fish community variable that expressed clear between-type differences was the number of sensitive species as in the case of preliminary lake types. The number of sensitive species was higher in the small clear-water lakes than in the small brown-water lakes and the difference was statistically significant.

Fig. 4.
The means and standard deviations (SD) of the most important fish community variables of the surveyed preliminary lake types. Statistically significant differences between the types are marked with lines and asterisks (ANOVA, * = p<0.05, ** = p<0.01), type 2: n = 5, type 3: n= 5, type 9: n = 4.



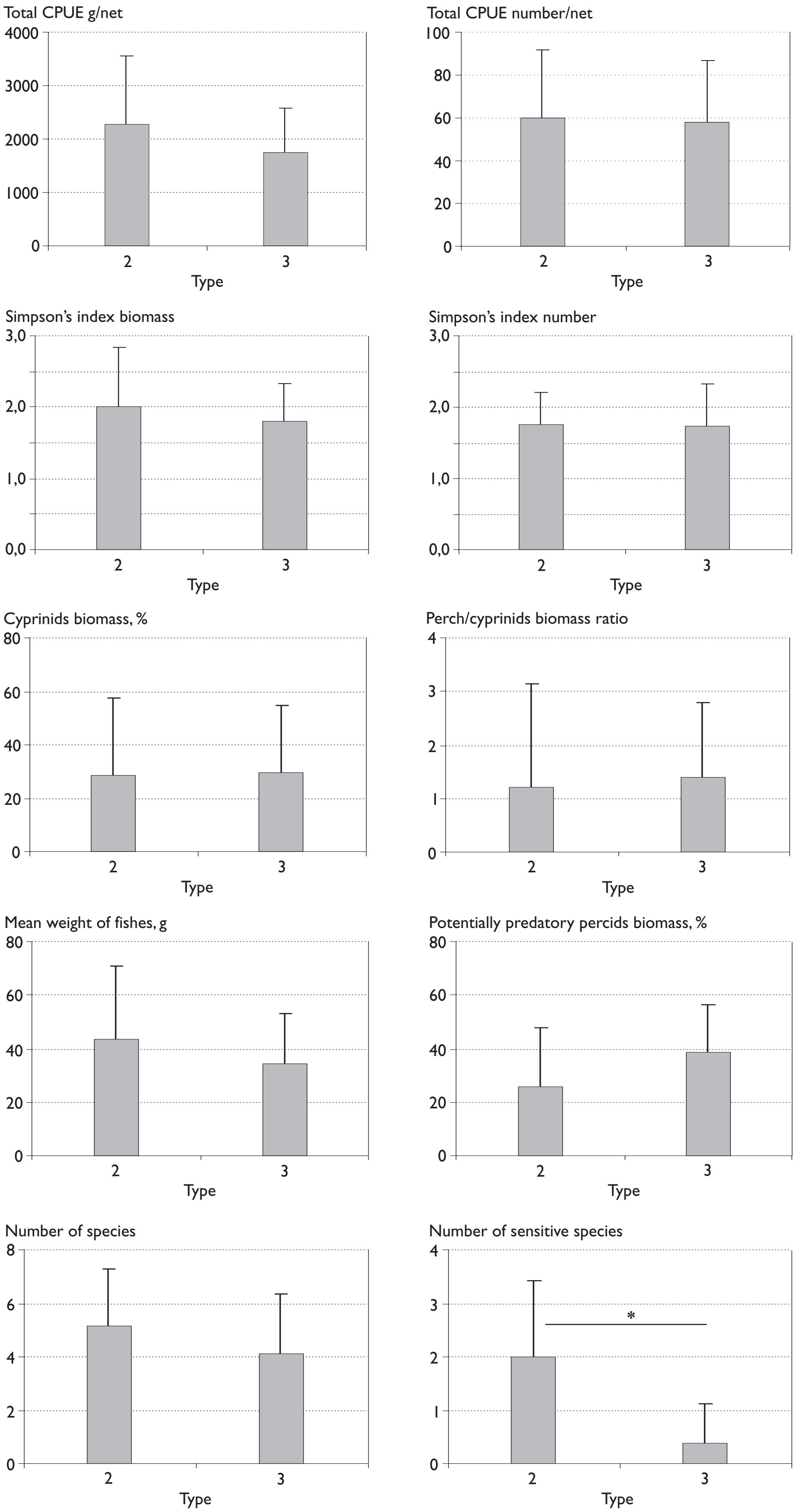


Fig. 5.
The means and standard deviations (SD) of the most important fish community variables of the surveyed revised lake types. Statistically significant differences between the types are marked with lines and asterisks (T-test, * = $p<0.05$), type 2: n = 6, type 3: n = 8.

5.3

Comparison of preliminary and revised TRIWA typologies

The testing results of preliminary and revised TRIWA typologies were quite similar. No statistically significant differences between lake types were found in total CPUE's, Simpson's indexes, biomass proportions, mean weight or number of species. In both typologies the number of sensitive species was the only fish community variable that expressed clear between-type differences.

No clear differences in preliminary typology were found between inland and coastal region lakes fish communities. In that sense the fish fauna results support the earlier results (Elfvendahl et al. 2006) of the other biological factors (benthic macroinvertebrates and phytoplankton). The observed differences in the number of sensitive species were depending on water colour. Ecoregion did not affect the number of sensitive species. Therefore revised typology where the lake types of inland and costal regions are combined seems justified. On the other hand, the number of sensitive species was also dependent on lake productivity, altitude and maximum depth (Fig. 6). Water colour, lake productivity, altitude and maximum depth together explained 63 % of the variation in the number of sensitive species (r2 = 0.629, p = 0.044), but most of the variation was explained by water colour and lake productivity (r2 = 0.606, p = 0.006). The small clear-water lakes (type 2) were on the average more oligotrophic, deeper and were situated higher above the see level than small brown-water lakes. These lake characteristics explain the number of sensitive species perhaps better than just water colour.

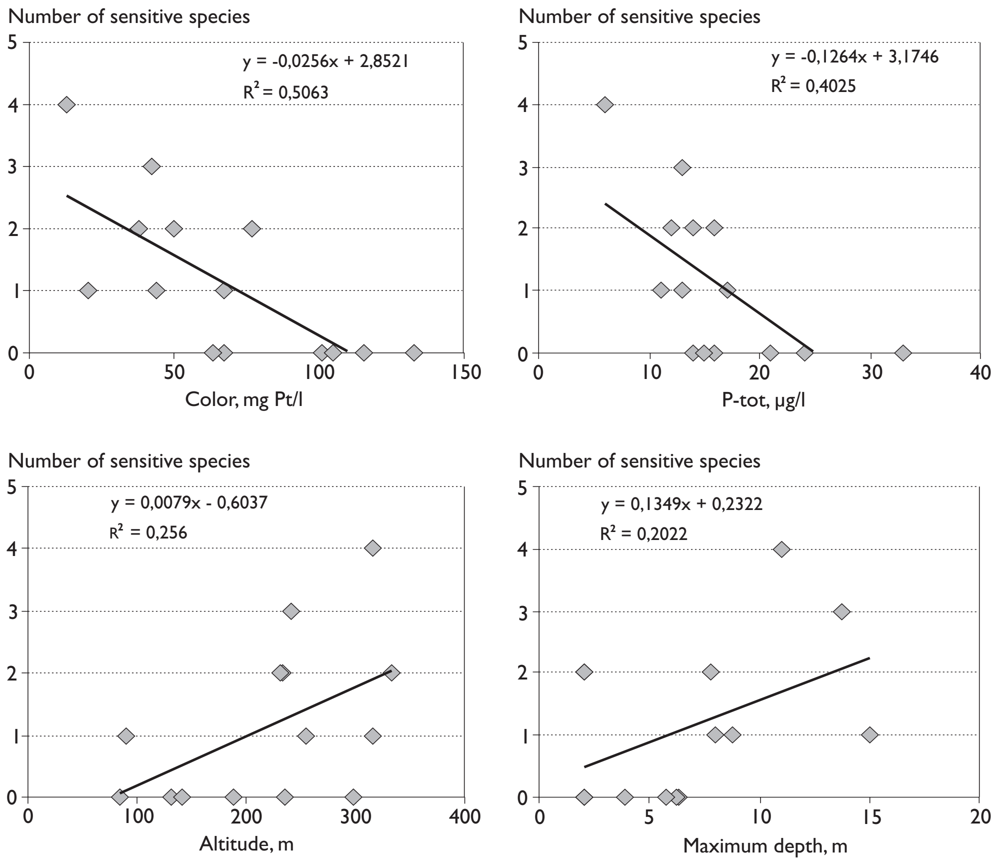


Fig. 6. Correlations between the number of sensitive species and water colour, lake productivity, altitude and depth of the surveyed lakes.

6. Fish community based ecological status of the survey lakes

6.1

Finnish EQR4

According to Finnish EQR4 the fish community based ecological status of the surveyed lakes was generally good or high (Fig. 7). The ecological status was moderate only in Lake Merijärvi and Lake Nivunkijärvi where the EQR4 values were lower than 0,6, which is the borderline between good and moderate conditions. In the case of Lake Merijärvi that was due to high total CPUE's (g/net and number/net) (Table 9). In the case of Lake Nivunkijärvi that was due to lack of indicator species. According to Finnish EQR4 the ecological status of lakes Puolamajärvi, Liehittäjäjärvi, Pirttijärvi and Suolajärvi was high. If only benthic nets were noticed the ecological status of lake Olosjärvi would change from good to high and lake Puolamajärvi from high to good. In the case of Lake Valkeajärvi the too high biomass catch of whitefish lead only to good overall ecological status. But according to Olin M. (personal comment) Lake Valkeajärvi should also be considered in the highest class. Thus the fish community based EQR4 results suggest that almost all the surveyed lakes are representing reference conditions, except lakes Merijärvi and Nivunkijärvi.

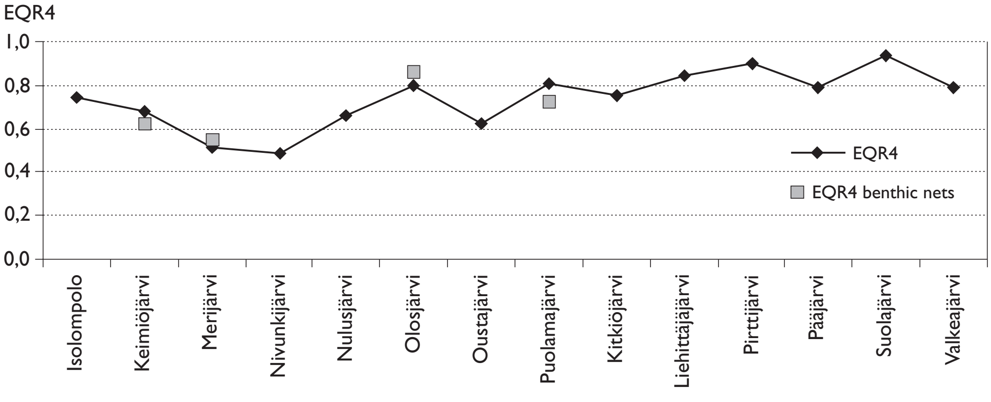


Fig. 7. The Finnish EQR4 values of the surveyed lakes. The borderline between good and moderate ecological status is 0,6.

Table 9. Ecological status of surveyed lakes according to Finnish EQR4.

Lake	Status class				
	CPUE biomass	CPUE number	Cyprinids % Biomass	Indicator species	EQR4
Isolompolo	Bad	High	High	High	Good
Keimiöjärvi	Poor	High	-	Good	Good
Merijärvi	Poor	Poor	High	Moderate	Moderate
Nivunkijärvi	Good	Good	-	Bad	Moderate
Nulusjärvi	Good	Good	Moderate	High	Good
Olosjärvi	Good	Good	High	High	Good
Oustajärvi	Good	Good	-	Good	Good
Puolamajärvi	High	High	Moderate	High	High
Kitkiöjärvi	Moderate	High	High	Good	Good
Liehittäjäjärvi	High	High	High	Good	High
Pirttijärvi	High	High	High	Good	High
Pääjärvi	High	Good	High	Good	Good
Suolajärvi	High	High	High	High	High
Valkeajärvi	Moderate	High	-	High	High

6.2

Swedish EQR8

According to Swedish EQR8 the fish community based ecological status of the surveyed lakes was generally moderate or poor (Fig. 8). The ecological status was good only in Lake Oustajärvi, Lake Pirttijärvi and Lake Valkeajärvi where the EQR8 values were higher than 0,46, which is the borderline between good and moderate conditions. In the cases of Lake Isolompolo and Lake Nivunkijärvi the ecological status was evaluated even bad (Table 10). In both cases the values of each variable lead to status classes bad or poor. The fish community based EQR8 results suggest that almost all the surveyed lakes are not representing reference conditions, except lakes Oustajärvi, Pirttijärvi and Valkeajärvi.

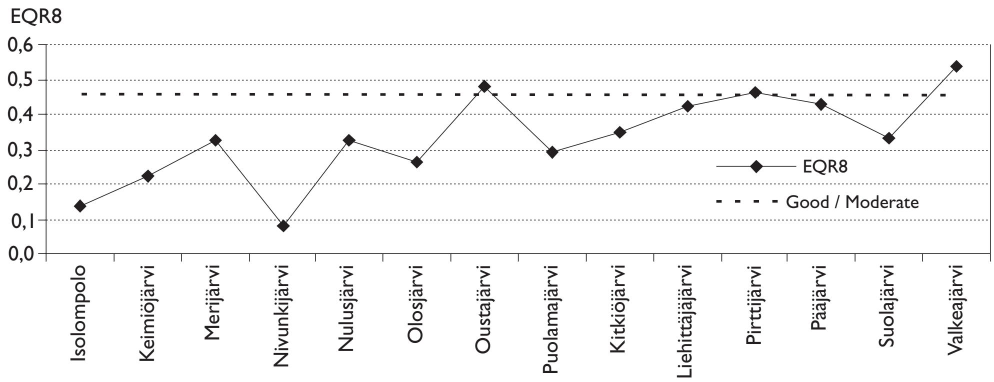


Fig. 8. The Swedish EQR8 values of the surveyed lakes. The borderline between good and moderate ecological status is 0,46.

Table 10. Ecological status of surveyed lakes according to Swedish EQR8.

Lake	Status class								
	Number of species	Simpson's index number	Simpson's index biomass	CPUE biomass	CPUE number	Mean weight	Potentially predatory percids	Perch/ cyprinids ratio	EQR8
Isolompolo	Bad	Poor	Bad	Bad	Bad	Poor	Poor	Bad	Bad
Keimiöjärvi	High	Bad	Moderate	Bad	Bad	Poor	Bad	-	Poor
Merijärvi	Good	Bad	Good	Bad	Bad	Good	Good	Bad	Moderate
Nivunkijärvi	Bad	Bad	Poor	Bad	Bad	Bad	Bad	-	Bad
Nulusjärvi	Bad	Poor	Good	High	Bad	Bad	High	Bad	Moderate
Olosjärvi	Bad	Moderate	Good	Bad	Bad	Bad	High	Bad	Poor
Oustajärvi	Good	Bad	Moderate	High	Good	High	Bad	-	Good
Puolamajärvi	Bad	Moderate	High	Good	Bad	Bad	Moderate	Bad	Poor
Kitkiöjärvi	High	Good	High	Poor	Bad	Poor	Bad	Bad	Moderate
Liehittäjäjärvi	Moderate	Poor	High	High	Poor	Poor	Moderate	Poor	Moderate
Pirttijärvi	High	High	High	Poor	Moderate	Bad	Poor	Poor	Good
Pääjärvi	Good	Poor	High	High	Bad	Bad	High	Bad	Moderate
Suolajärvi	Bad	High	Bad	Good	Bad	Bad	High	Bad	Moderate
Valkeajärvi	Good	High	Moderate	Poor	Poor	High	-	-	Good

6.3

Comparison of national EQR's

The results from two different national EQR methods were almost opposite. According to Finnish EQR4 results the ecological status of the surveyed lakes was generally good and the lakes are representing reference conditions (Table 11). Whereas, according to Swedish EQR8 results the situation was quite opposite. In that sense the fish community based Finnish EQR4 results support the earlier results (Elfvendahl et al. 2006) of the other biological factors (benthic macroinvertebrates and phytoplankton) and water chemistry. Because according to earlier results the survey lakes are representing reference conditions. The Finnish EQR4 values were also calculated separately for benthic nets, but the influence to overall results remained minor. The ecological status class of the lakes Keimiöjärvi and Merijärvi remained similar. Whereas, the ecological status class of lake Olosjärvi would change from good to high and lake Puolamajärvi from high to good. Generally the ecological status of each lake was according to Finnish EQR4 1 to 2 classes higher than according to Swedish EQR8. But for example in the case of Lake Isolompolo the fish community based ecological status was good according to EQR4, whereas according to EQR8 the ecological status was bad. Also in the case of Lake Puolamajärvi the results were quite opposite. Only in the case of lakes Merijärvi and Oustajärvi the results were similar. According to both methods the ecological status in Swedish lakes was generally higher than in Finnish lakes. The Finnish EQR4 is simple and seems to give easier higher status classes than Swedish EQR8, which seems to be more conservative method. A previous study also indicated that EQR8 might work less well for lakes in northern Sweden (Holmgren 2007). For example the northernmost national reference lakes had higher NPUE and proportion of piscivorous percids than expected from lake-specific reference values. A similar pattern was found for NPUE of all lakes in the present study, and for proportion of piscivorous percids in six lakes. It might be also noted that no lakes from the Torne River catchment were included in the calibration data set used for defining lake-specific reference values. Perhaps both methods should be developed before using in practice, because the results are now too far from each other.

Table 11. Ecological status of surveyed lakes according to national EQR's.

Lake	Status class	
	EQR4	**EQR8**
Isolompolo	Good	Bad
Keimiöjärvi	Good	Poor
Merijärvi	Moderate	Moderate
Nivunkijärvi	Moderate	Bad
Nulusjärvi	Good	Moderate
Olosjärvi	Good	Poor
Oustajärvi	Good	Good
Puolamajärvi	High	Poor
Kitkiöjärvi	Good	Moderate
Liehittäjäjärvi	High	Moderate
Pirttijärvi	High	Good
Pääjärvi	Good	Moderate
Suolajärvi	High	Moderate
Valkeajärvi	High	Good

7. Conclusions and future perspectives

In TRIWA I project, a preliminary lake typology was suggested including three main groups, mountain lakes, inland lakes and coastal lakes. Comparison of selected fish community parameters of humic coastal and humic inland lakes of this study indicated no significant differences. Therefore, the revised harmonised typology where the groups inland lakes and coastal lakes are combined, seems to be justified.

Comparison of lake types 2 (small clear water lakes) and 3 (small brown water lakes) in the revised system resulted in a significant difference only for the fish community parameter number of sensitive species. In case of the other variables the variation within the lake types was too high. Apparently the concentration of humic substances in the water is not the only factor affecting the number of sensitive species. Therefore attention should be paid also to other lake characteristics such as depth relations.

The limited number of lakes in this study (n=15) allows no meaningful comparison of Finnish and Swedish national typologies that may include a maximum of 12 and 48 lake types in the Torne River basin, respectively.

The ecological status of the lakes was assessed both with the Finnish EQR4 and the Swedish EQR8 procedure. According to the Finnish EQR4, 12 out of 14 lakes were classified to good or high status whereas according to the Swedish EQR8 only three of the lakes obtained the status good and even five lakes This work was one of the responses to TRIWA II goals to evaluate the suitability of selected aquatic biota, here fish assemblages in lakes, for assessing the environmental status of the Torne River system. The work was based on data gathered during this project and data gathered during the TRIWA I project.

were classified to poor or bad status. The classification results from the Finnish protocol were closer to the ecological status obtained in TRIWA I project by using phytoplankton and benthic macroinvertebrates data. Keeping in mind that the TRIWA lakes were originally selected to meet and determine reference conditions, it seems that the Swedish EQR8 system resulted in too low values of ecological status of lakes.

The striking differences in the classification output between the Finnish EQR4 and the Swedish EQR8 system was discussed in an expert meeting in Trondheim, 4-6 June 2007. Several potential reasons for the different results were found. In the Swedish classification tool all variables are two-tailed and therefore sensitive also to low values of test fishing catches in order to detect the effects of acidification. In the Finnish method only the variables total biomass and number of individuals were two-tailed. There has been also essential differences in the reference lake material of the countries: the Swedish lake set consisted more of oligotrophic and acid sensitive highland lakes whereas the Finnish reference lake set was dominated by more productive lakes of lowland. As a result, the Finnish tool may be more reliable for classification of eutrophied lakes whereas the Swedish one may be better for acidified lakes.

The possibility to develop a common Nordic lake classification system was discussed preliminarily. The participants agreed that this would be a better alternative than continue with the intercalibration of two different systems. However, preparing a new tool demands both time and money, and, especially, more fish community data both from pristine reference lakes and from lakes affected by human activities. In the meanwhile, using of the Finnish EQR4 is recommended for fish based classification of lakes in the international river basin district of River Torne.

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Part II

Ecological indicators

B. Phytobenthos

Ecological state of the River Torne – phytobenthos 2006

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Eira Luokkanen

CONTENTS

1. Introduction

1.1
Description of the watershed

This short introduction to the conditions in The River Torne (*Tornionjoki* in Finnish, *Torne älv* in Swedish) watershed is based on a larger introduction in Puro-Tahvanainen *et al.* (2001). The catchment area of the River Torne is 40 157 km^2, of which 25 393 km^2 is situated in Sweden, 14 480 km^2 in Finland, and 284 km^2 in Norway. River Torne runs from the Lake Torneträsk to the Baltic Sea. Part of the water is diverted to River Kalix in Junosuando, via River Tärendö. Length of the River Torne is 470 km from the Lake Torneträsk to the Bothnian Bay, and 520 km from the Lake Kilpisjärvi via rivers Muonio and Torne to the Bothnian Bay.

The watershed of the river includes mountain areas with several mountains over 1000 m high. However, these mountain areas form only a minor part of the watershed; for most of the area the altitude is 200–500 m a.s.l. The lower part of the river (down from Övertorneå) the altitude is below 100 m a.s.l. Overall, the main channel of the River Torne is fairly gently sloping – the ecoregion of the Lake Torneträsk is only 342 m a.s.l.

The watershed is situated in middle- and north boreal vegetation zones. Middle boreal zone reaches up to Lainio and Vittangi areas in the north along the River Torne. In the middle boreal zone, pine and mixed forests dominate the landscape over spruce in more moisture soils. In the north boreal zone, the forests are sparser. Areas above tree limit belong to the alpine vegetation zone.

For most part, the watershed of the river is situated on the Fennoscandian shield, with 1.6–2.7 billion years old bedrock. In the mountain area, the bedrocks are intrusive sediment- and volcanic-based rocks, which are easily weathering, and often calcareous. These calcareous rocks are also abundant in areas north and west from Pajala, and in the Kolari, Övertorneå and Tornio areas. The dominating soil type is moraine, which originates from the material detached from the bedrock by ice. Another common soil type is organic peat, especially in the middle- and lower parts of the watershed.

1.2
Utilization and quality of the waters

In the watershed of the River Torne, only the Rivers Tengeliönjoki and Puostijoki are dammed for the energy production. Other artificial constructions of the river banks, concentrated on the Finnish side, are connected to recreational use and protection from floods and erosion (Puro-Tahvanainen *et al*. 2001).

Diverse types of utilization affect the water quality in the river. In southern Finnish Lapland, about 30–50 % of the peat area is ditched for use in agriculture and forestry (Penttilä 1989), increasing the load of humic matter, nutrient and solid substances into the rivers. Point source pollution in the watershed derives mostly from waste water treatment plants with varying contaminant removal efficiency. In addition, there are some peat production fields both in Finland and Sweden, and fish farming in Finland.

As a whole, the level of anthropogenic loading is relatively low in the area: the total phosphorus load to the surface waters is estimated to be about 250 000 kg/yr, of which background load forms 77 %. Total nitrogen load estimation is 5 100 kg/yr, of which 74 % is background loading (Puro-Tahvanainen *et al*. 2001). However, high levels of loading are found in small scale in some tributaries of the River Torne. The highest levels of anthropogenic loading are found in the lower parts of the river (Puro-Tahvanainen *et al.* 2001).

The water quality of the rivers Torne and Muonio has been followed since the early 1960s. One site in the River Muonio (Palojoensuu) and three sites in the River Torne (in Pello, Kukkola and Mattila) have been monitored continuously since the 1960s or 1970s. Several tributaries of the River Torne have been monitored in shorter periods for water quality and macroinvertebrates (Puro-Tahvanainen *et al*. 2001).

According the monitoring results of the rivers, upper part of the River Torne in Sweden is clearwatered, and the watercolour (i.e. humic matter) is increasing downstream. Water is also clear in the upper part of the River Muonio, but its tributaries bring humic matter from the peat bogs and forests, and the colour of the water rapidly increases in the area of Kaaresuvanto–Palojoensuu. Median concentration of total organic carbon is about 1.7 mg l^{-1} in upper parts of the River Torne, 3.5 mg l^{-1} in the River Muonio, and 4.7–5.1 mg l^{-1} in the middle and lower reaches of the River Torne (Puro-Tahvanainen *et al.* 2001).

Total phosphorus (TP) and total nitrogen (TN) concentrations reflect oligotrophy in the rivers Muonio and Torne. Only the lowest part of the River Torne can be considered mesotrophic, i.e. TP concentrations are 15–25 µg l^{-1} (Puro-Tahvanainen *et al*. 2001).

In some of the smaller tributaries, the concentrations of nutrients and humic matter may be much higher than in the main channel. Puro-Tahvanainen *et al.* (2001) report that in Naamijoki and Martimojoki extensive ditching of the soils has deteriorated the water quality. In Martimojoki, also peat mining is responsible for the high amounts of solids, nutrients and humic matter. Humic matter lowers the pH levels in the rivers, but at the same time increases buffering capacity, so that strongly acid conditions (pH<5) are not usually found in the rivers.

1.3
River typologies

According to EU Water Framework Directive, all rivers have to be allotted to ecologically meaningful river types, and biological reference conditions must be described for these types. The ecological quality status of the rivers is then determined by deviation from the reference conditions.

In TRIWA project, four different systems of typology of rivers have been tested for use in the assessment of reference conditions and ecological classification of the rivers: Finnish typology (FIN; Ministry of the Environment 2006), Swedish proposed typology (SWE, Fölster *et al*. 2004), original project TRIWA typology (TRIWA1; Elfvendahl *et al*. 2006), and revised TRIWA typology (TRIWA2; Elfvendahl *et al*. 2006).

In all of these typologies, ecoregion, catchment size and geology of the catchment area are used for determining the types directly or indirectly. Ecoregion is connected to the altitude – one category limit is either conifer tree limit (TRIWA1, TRIWA2) or highest historical coastline (FIN), that are both included in ecoregion definitions in

SWE. Geology factor has two possible limits: > 20 % of peatland (TRIWA1, TRIWA2) or > 25 % of peatland in the catchment area (FIN) denoting organic geology in the catchment area. Swedish national typology replaces the geological factor by hydrological factors: colour (≤50 mg Pt l^{-1} or > 50 mg Pt l^{-1}) and alkalinity (≤1.0 mekv or > 1.0 mekv).

In Finnish typology a separate abbreviation is used for rivers that run above the tree line in North Lapland, i.e. first the rivers are defined according the basic typology and an additional PoLa (Pohjois-Lappi, North Lapland) separates these rivers from those below the tree line.

The Finnish and TRIWA typologies also use catchment size as a typology factor, with limiting areas 100 (only FIN), 1000, and 10 000 km^2. The revised typology of rivers in the Torne catchment area suggested by TRIWA project (TRIWA2) is presented in Fig. 1.

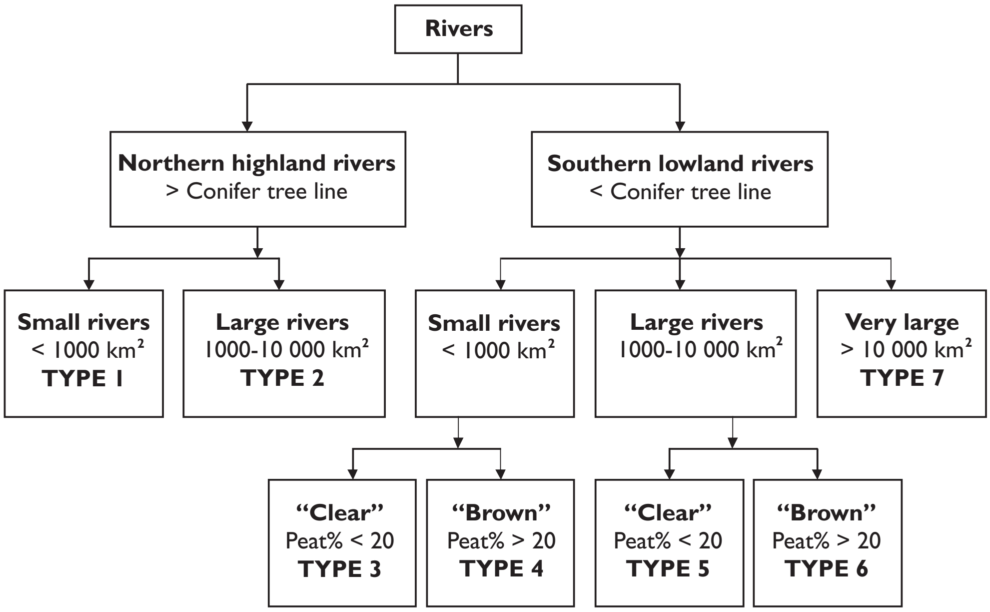


Fig. 1. Revised harmonized typology for rivers in Torne River Watershed (Figure from Elfvendahl *et al.* 2006).

1.4

Aims of the study

In this study, diatom based methods are tested for assessing ecological conditions in the River Torne area. Also the suitability of the proposed river typologies are tested for the biological element phytobenthos, according to the WFD. At the same time, the ecological conditions of running waters in the watershed are surveyed using phytobenthos.

The survey of the diatom communities adds information on the impacts of land use and nutrient loading on the water quality. Diatom communities on the hard surfaces integrate information on the water quality during a period of months before the sampling (Jarlman *et al.* 1996).

Although several groups of algae form the phytobenthos, diatoms are routinely used as an indicator group for the phytobenthos. Diatoms are good indicators of water quality, because they are very diverse both taxonomically and ecologically, and the ecological requirements of the species are relatively well known (Eloranta 2000).

2. Material and methods

2.1

Sites and sampling

During August 6th-16th 2006, 49 sites were sampled in the River Torne catchment area (Fig. 2). In Table 1, the river type for each site is defined according to the TRIWA2 typology. Only one sample for each site is analysed, because results gained from parallel diatom samples have been found almost identical in earlier studies (Miettinen 2003, 2006). Water samples were taken at the studied sites simultaneously for physical-chemical analyses. The results are available at www.triwa.org.

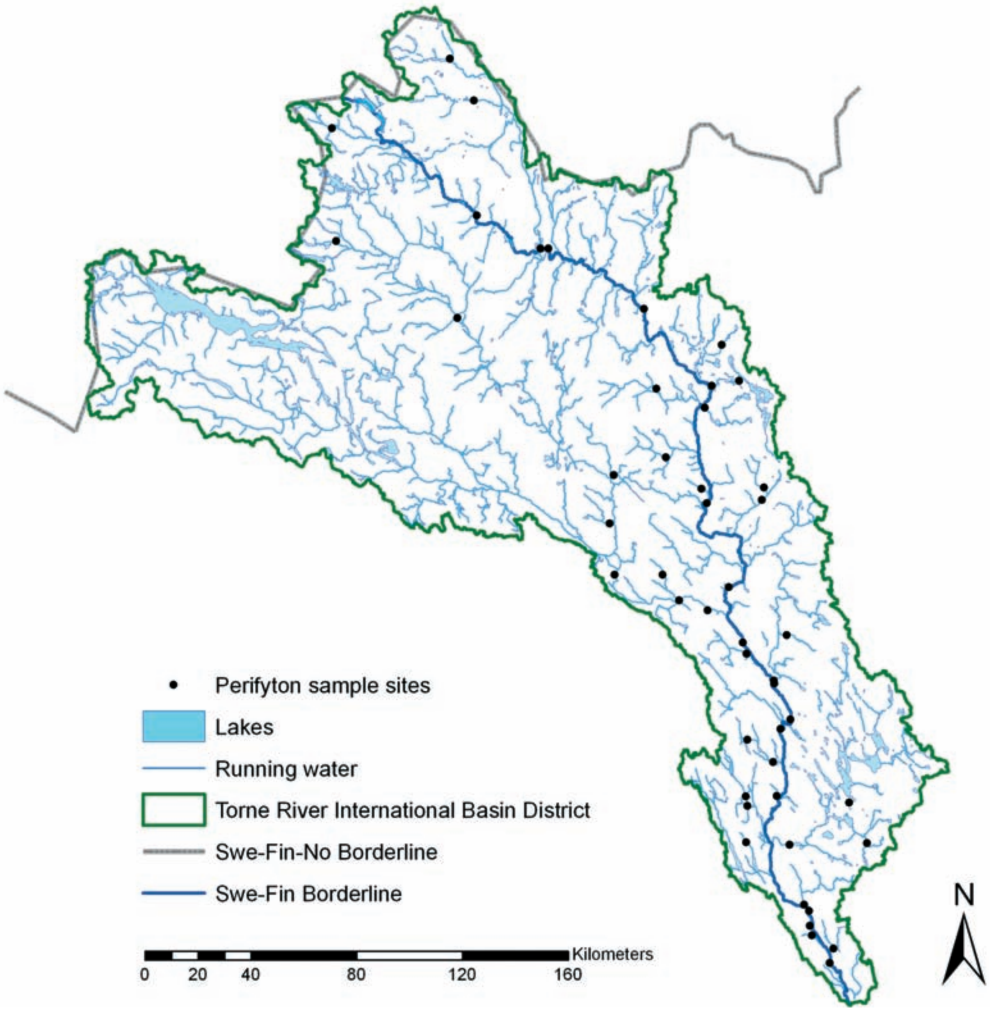


Fig. 2. Catchment area of the River Torne and the studied 49 sites.

One of the five sampling sites in mountain type rivers studied in the earlier TRIWA-project, Lafoljåkka, was replaced by a sample in the River Lainio just below the mouth of the River Lafoljåkka by mistake. The site is named Lafoljåkka/Lainio below.

Sampling was done according to the European standard (CEN/TC230 2002). Type of river bottom and abundance of macrovegetation were evaluated, and water temperature measured at every site. From every sampling site, five cobbles (stones with diameter 6-26 cm) were collected. The diatom film was rubbed from the stones using toothbrush. Macroalgae and mosses were brushed also into the samples, but long filaments of macroalgae were cut off, and cobbles most covered with macrovegetation were avoided. Each sample (five cobbles) was brushed in water, the water was mixed, and 100 ml of the mixture was poured in a plastic bottle. At the sampling sites, 1 ml of buffered formalin solution was added into the samples.

Table 1. Sampled sites 6th –16th August 2006. River type according to the revised TRIWA2 typology. Sites marked TRIWA were included in the TRIWA I project. Coordinates are listed here according the Finnish "Peruskoordinaatti" system; Swedish coordinates are available at www.triwa.org.

Ref.site	river type	Site	coord. PK (Y)	coord. PK (X)	country	area km^2	peat land%	fields%	peat mining %
R	1	Kåbmejåkka TRIWA	7658939	3237258	SE	102.2	2.02	0	0
R	1	Lafoljåkka/Lainio älv TRIWA	7580497	1508711	SE	?	?	0	0
R	1	Poroeno TRIWA	7668128	1514591	SE	158	1	0	0
R	1	Rommaeno TRIWA	7658187	1519127	SE	381	1	0	0
R	1	Skittsekallojåkka TRIWA	7584552	1468625	SE	59.71	5.57	0	0
R	2	Könkämäneno	7587518	1517787	FI	1496	3.48	0.02	0
R	2	Lainio älv, Jårkastaka	7564734	1511276	SE	2478	9.23	0.01	0
R	2	Lätäseno	7607629	3306606	FI	2151	4	0	0
R	3	Ylinen Kihlankijoki	7475872	2469359	SE	86.82	13.3	0.72	0
R	3	Olosjoki	7518246	3318386	SE	241.7	17	0.9	0
R	3	Äkäsjoki	7471354	2482719	FI	495	11	0.03	0
	3	Jerisjoki Muonio	7544932	3360905	FI	318	18	0.1	0
	3	Juojoki	7387829	3357398	SE	78.23	9.08	6.18	0
	3	Kannusjoki	7386117	3345739	SE	68.28	14.1	1.31	0
	3	Kuittasjoki	7400665	3358259	SE	274.8	12.9	1.39	0
	3	Ylinenjoki	7360646	2469428	SE	177.8	19.6	0.41	0
R	4	Jerisjoki Toras-Sieppi TRIWA	7544796	3371506	FI	263	21	0.13	0
R	4	Keräsjoki TRIWA	7559429	3367541	SE	112	27	0.1	0
R	4	Kuerjoki TRIWA	7474010	2500738	FI	162	20	0	0
R	4	Käymäjoki TRIWA	7457622	2457939	SE	194.1	46.8	0.72	0
R	4	Jylhäjoki TRIWA	7410711	3350250	SE	145	15.8	0.7	0
R	4	Kuijasjoki TRIWA	7364149	3387757	SE	359	53	1.58	0.16
R	4	Naalastojoki TRIWA	7440122	2501489	FI	82	33	0.01	0
R	4	Orjasjoki TRIWA	7372578	3342827	SE	62.62	13.4	0.64	0
R	4	Parkajoki TRIWA	7521252	3339050	SE	632.1	17	0	0
R	4	Tupojoki TRIWA	7443102	3355580	SE	172.5	29.7	1.64	0
R	4	Kangosjoki	7493882	2472581	FI	291	24.3	0.1	0
R	4	Rukojoki	7499644	2462192	SE	55.4	24.6	0	0
R	4	Nuuksujoki	7500575	3313840	SE	95.16	24.7	0.42	0
	4	Kaartijoki	7337223	3361145	SE	91.36	26.9	9.36	0
	3	Liakanjoki	7327222	3368250	FI	272	21.5	2.3	0
	4	Liviöjoki	7451337	2460911	SE	179	38.6	0.89	0

Ref.site	river type	Site	coord. PK (Y)	coord. PK (X)	country	area km^2	peat land%	fields%	peat mining %
	4	Mertajoki	7448245	2467107	SE	66.74	40.1	1.56	0
	4	Martimojoki	7345493	3360262	FI	365	59	1.4	0.61
	4	Matojoki	7333608	3361101	SE	274.8	27.7	9.12	0
	4	Puruoja	7412474	3363239	SE	51.38	28.7	1.8	0
R	5	Muonio Markkina	7607061	3309535	FI	5732	8.06	0.08	0
R	5	Muonio Palojoensuu	7562529	2462390	FI	8025	16.2	0.23	0
	6	Naamijoki 290	7430917	3364142	FI	?	27	1.38	0
	6	Naamijoki K2	7429800	3364000	FI	1267	27	1.38	0
	6	Tengeliönjoki Pessakoski	7380445	3383764	FI	1338	32	0.61	0
	6	Tengeliönjoki Portimo	7349503	2477842	FI	3119	36	0.63	0
	7	Muonio Törmäsniva	7468780	3353572	FI	14561	23	0.56	0
R	7	Muonio Vanha-Kihlanki	7501519	3351041	FI	11784	19.9	0.47	0
R	7	Torne Huhtinen	7459733	1559707	SE	16103	14.8	0.18	0
R	7	Torne Kassa	7439872	2473922	SE	31683	19.5	0.34	<0.01
	7	Tornionjoki Pello	7376508	2481906	FI	33847	20.7	0.38	<0.01
R	7	Tornionjoki Matkakoski	7343931	3361542	FI	39017	21.9	0.62	<0.01
	7	Tornionjoki Kukkola	7275900	2501397	FI	40027	21.5	2.3	<0.01

2.2
Reference vs. impacted sites

Of the 49 sites studied in this project, 15 have been studied earlier in TRIWA I project (Elfvendahl *et al.* 2006) for water quality and zoobenthos communities. These sites were chosen to represent reference, not anthropogenically altered, conditions in the TRIWA project. Of the remaining 34 sites in this study, reference sites were selected based on the following criteria:

- cultivated area less than 1 % of the catchment area above, - no hydrological alteration (regulation of the water level or artificial river banks at the studied site),
- no major point source pollution (e.g. wastewater treatment plant in the vicinity of the site).

Of the 34 "new" sites, 15 fulfilled these criteria, and were chosen as reference sites, and the remaining 19 sites were chosen to represent impacted conditions in this study. During the writing of this report, additional data was received for the sites Liviöjoki and Ylinenjoki, indicating they fulfil the criteria for reference sites, but they are represented as impacted in the analyses.

2.3
Identification and enumeration of diatoms

The preparation of the samples, as well as identification and counting of the diatoms was done according to European standards (CEN/TC230 2002, 2004). Part of each sample was used for diatom slides, and the rest is stored in 4–8°C temperature. For diatom analysis, 30% hydrogen peroxide was used to remove all organic material from the samples. Permanent slides were prepared by drying about 0.2 ml of diluted sample on a cover glass, and gluing it to a heated slide with Naphrax®.

Diatoms were identified according to Krammer & Lange-Bertalot (1986–1991). For some taxa, new names in the list of Naturvårdsverket (2005) were used. A minimum of 400 diatom frustules was counted from each of the samples, and identified to the species level when possible. One diatom cell forms two frustules that are counted as separate units. Magnification of 1000× and phase contrast optics were used for the counting. The abundance of each of the taxa was divided by the sample size, and the relative abundances are used for the multivariate analyses.

2.4
Testing diatom indices

Three indices, used earlier in Finland (e.g. Eloranta & Soininen 2002), are tested for use in the Torne catchment area: IPS (Index of Pollution Sensitivity; Coste & Ayphassorho 1991), GDI (Generic Diatom Index; Rumeau & Coste 1988), and TDI (Trophic Diatom Index; Kelly & Whitton 1995, Kelly 1998). IPS is used also in Sweden (Kahlert *et al.* 2006).

IPS and GDI aim to assess both organic load (saproby) and trophic level of rivers, TDI only trophic level. In GDI, only genera are used, in TDI both species and genera, and in IPS always the lowest taxonomic level possible (reaching up to 2500 taxa). IPS and GDI are based on weighted averaging of the species indicator values.

The indices were calculated using software Omnidia (Lecointe & Coste 1993), version 4.2 (2006). Additional sensitivity and indicator values for some taxa by Amelie Jarlman are included in the calculations (Naturvårdsverket 2005).

The indices were tested for the detection of pressures (land use, pollution, and hydrological alteration) by T-tests of the equality of means in sites classified as reference and impacted. The pressure-metric relationships were assessed by correlation coefficients between the indices and pressure metric (field percentage in the catchment) and water quality (total P concentration).

2.5
Testing the different river typologies

The value of the different typology factors (ecoregion, catchment size, geology) for explaining the composition of diatom communities in reference sites was assessed with 1) testing if the within-type variation in the diatom data is smaller than the variation between types by Multi-Response Permutation Procedures (MRPP); 2) grouping of the sites in multivariate ordination.

MRPP (Mielke & Iyer, 1982) tests were run with program PC-ORD v. 4.25 (McCune & Mefford, 1999). In MRPP, the within-group agreement $A = 0$ when heterogeneity within groups equals expectation by chance, and $A = 1$ when all samples are identical within groups. If $A < 0$, there is more heterogeneity within groups than expected by chance.

The MRPP tests were run separately for each limiting factors, e.g. mountain rivers vs. inland rivers in forested areas. This way the number of samples is larger in each test than when testing the system of typology in one test. Also separate tests have the advantage that the value of each of the typology factors (ecoregion, catchment size, geology) can be evaluated individually.

After evaluating the factors separately, the different typologies were tested for the combined factors, i.e. the grouping of the samples according to the types. This was done by an indirect form of multivariate ordination, Detrended Correspondence Analysis (DCA; Hill & Gauch 1980). Ordinations using only the species data are called indirect ordination methods. The direction of the ordination axes are set to capture the maximum amount of variation in the data, which are typically explained by combinations of environmental factors. The closer two samples are to each other in the ordination space, the more similar their diatom taxa composition is (ter Braak 1987).

In DCA, unimodal responses to environmental variables are assumed for the species. When the length of the first ordination axis exceeds two of these variation units, most of the species are considered to respond unimodally to the differences in the samples (ter Braak & Prentice 1988). If the first ordinations axis is shorter than this, linearly based methods are more appropriate. Program CANOCO 4 (ter Braak & Šmilauer 1998) was used for the ordinations.

For the sites studied earlier in TRIWA project, the types used in Elfvendahl et al. (2006) are used also in this study. For other sites, the types are based on catchment data in the Finnish and Swedish national data archives (Hertta-database in Finland and County administration in Sweden). The watercolour values, which define the geological type in the Swedish typology, are taken from the Elfvendahl *et al*. (2006) for the TRIWA sites, and for the other sites from the single samples taken together with the periphyton samples in August 2006. All the sites classified as reference sites, have water alkalinity values less than 1.0 mekv for the year 2006.

2.6

Describing reference conditions

Reference conditions were described as IPS values attributable to the sites within the river types. Median of the index values within a river type can be used as the expected value in reference conditions. 25th percentile of the values in the reference sites is generally used as the limit for high ecological status.

2.7

Determining ecological status

Two methods for classifying the ecological status were compared: using the national Finnish or Swedish status boundaries for the IPS values. The proportions of diatom taxa indicating different ecological properties were used for an additional measure of the ecological status: the ecological classifications of Van Dam *et al*. (1994) were used to calculate the proportion of diatom frustules indicating different trophy levels and saprobity classes at the sampled sites.

3. Results

Total of 171 diatom taxa were identified. Mean number of taxa in one site was 31, minimum 18 (Jylhäjoki), and maximum 43 (Kaartijoki, Torne Pello). The amount of taxa in one sample generally increases with increasing trophy level. The most abundant taxa in the data are *Fragilaria capucina* var. *gracilis*, *Achnanthes minutissima*, and *Tabellaria flocculosa*, all very common diatoms in oligotrophic northern rivers (e.g. Soininen 2002, Niemelä *et al*. 2002, Miettinen 2006, 2007). Detailed species lists are available at www.triwa.org.

3.1

Human impacts in the studied sites

DCA for the 49 samples in the Torne catchment area resulted in Eigen values of 0.402 and 0.225 for the ordination axis 1 and 2, respectively. The length of the first ordination axis is 2.52 standard units, which implicates that the variation in the data set is large enough for the use of DCA in ordinating the sites. In Fig. 3, the so called impacted and reference sites are presented on the DCA ordination axis 1 and 2 (no transformation of species data, down weighting of rare species). In the ordination, the sites with significant known pressures (agriculture, forestry and/or peat ditching) in their catchments are mostly separated from the reference sites in the ordination.

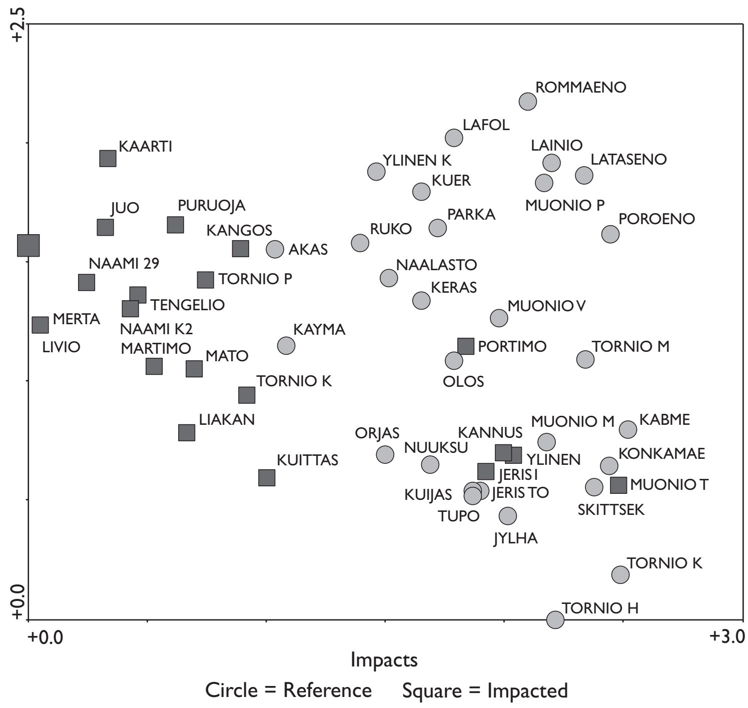


Fig. 3. DCA ordination for the 49 sites studied in the River Torne watershed. The reference samples are marked by gray circles, and sites with human pressures by dark gray squares.

The pressures in the catchment areas can be easily seen as impacts on the diatom communities, with some exceptions: Kannusjoki, Nuuksujoki and Tengeliönjoki Portimo. River Muonio Törmäsniva site (Muonio T) is situated below a small waste water treatment plant, and so is allotted to the impacted category, but no impacts are found in the diatom composition. On the other hand, reference sites Kangosjoki and Äkäsjoki are grouped together with the impacted sites, which may be explained by settlements and field cultivation near the sampling site Kangosjoki, and construction works upstream the Äkäsjoki site (Äkäslompolo).

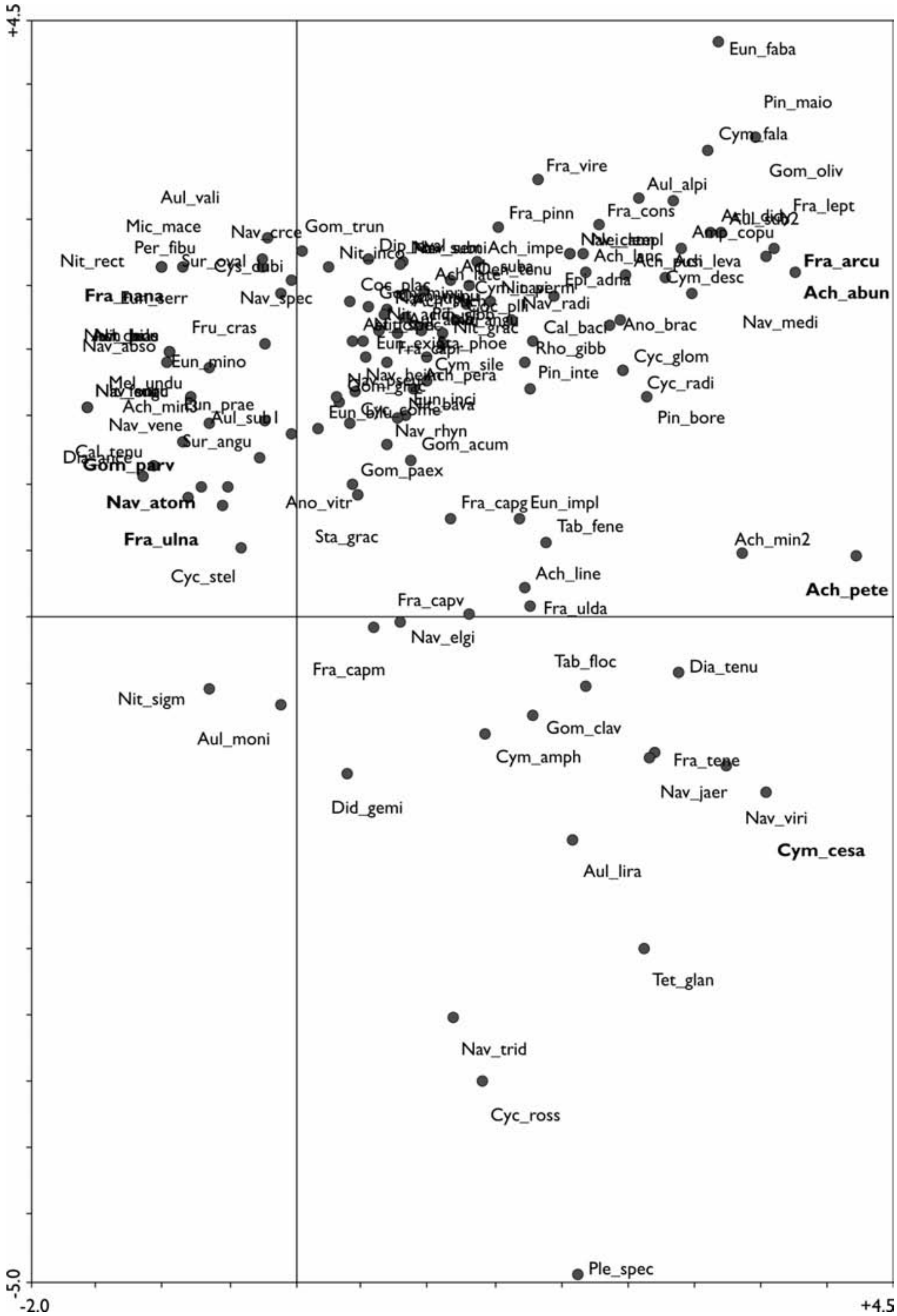


Fig. 4. DCA ordination for the diatom taxa in the 49 sites studied in the River Torne watershed. Taxa mentioned in the text are printed with bold font. Genus names are presented by first three letters, and species names by four letters, except when subspecies are identified they are presented by the last letter of the abbreviation.

The ordination of the diatom species (Fig. 4) indicates that the first ordination axis (horizontal) is reflecting the trophy level of the sites, with species indicating oligotrophy ordinated to the high end (right side) of the axis. The abundant species indicating oligotrophy include *Achnanthes abundans*, *Fragilaria arcus*, *Achnanthes petersenii* (Ach_pete) and *Cymbella cesatii* (Cym_cesa). The species or forms indicating eutrophy or pollution include *Fragilaria nanana*, *F. ulna* var. *ulna*, *Gomphonema parvulum* var. *parvulum* and *N. atomus* (Nav_atom).

3.2

Testing the diatom indices

Independent samples T-tests were used to indicate if the indices can detect the land use and other impacts on the river sites (Table 2) and these differences were visualised with box-plots (Fig. 5). IPS and TDI receive statistically significant differences ($p < 0.05$) in the mean values of reference vs. impacted sites.

Reference samples receive shorter range of IPS values than GDI or TDI values, indicating that IPS is better detecting reference conditions than GDI or TDI. GDI is very insensitive to the pressures identified, since the lower quartile GDI value for reference sites is almost identical to the impacted sites.

The effect of the pressure variables on the diatom metrics was studied by correlations between the indices and pressure metrics (cultivated land % and total P concentration), presented in Table 3. IPS and GDI have significant correlations ($p < 0.05$) with both the pressure variables.

IPS is the only metric out of these three, that statistically both correlates strongly with the pressure variables, and is sensitive to the pressures (difference in reference vs. impacted sites). Based on the results, only IPS is suitable for use in the ecological classification of the sites.

Table 2. T-tests for the equality of means in the reference and impacted sites using IPS, GDI and TDI. Equal variances are not assumed.

			Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
	t	d.f.	p			Lower	Upper
IPS	2.442	21.970	0.023	1.3444	.5506	.2024	2.4864
GDI	.793	38.318	0.433	.3074	.3875	-.4768	1.0916
TDI	2.155	38.447	0.037	.9933	.4609	.0607	1.9260

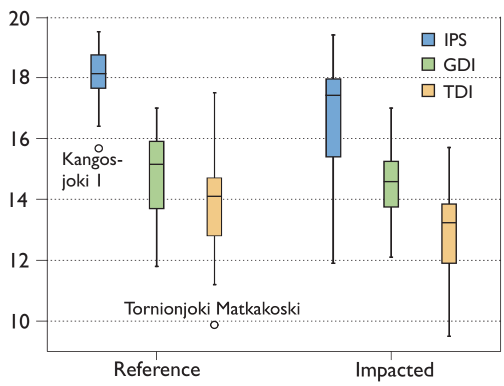


Fig. 5. Distribution of IPS, GDI and TDI values in reference (N=30) vs. impacted sites (N=19).

Table 3. Correlation coefficients between the diatom indices and pressure variables (percentage of cultivated land in the catchment area and total P concentration in the water) for the 49 sites.

		cultivated	total P
IPS	Pearson correlation	-0.632	-0.702
	Sig. (2-tailed)	>0.001	>0.001
GDI	Pearson correlation	-0.296	-0.344
	Sig. (2-tailed)	0.039	0.017
TDI	Pearson correlation	-0.213	-0.198
	Sig. (2-tailed)	0.141	0.178

3.3

Testing the different river typologies

MRPP for the diatom data (Table 4) proved significant effects of alpine vs. inland areas ($p < 0.001$), small vs. large catchment area ($p = 0.028$) and organic vs. inorganic geology ($p = 0.019$). Highest historical coastline and catchment size limit 10,000 km^2 did not prove to be significant in explaining the diatom composition at the sites.

Table 4. MRPP results testing the amount of variance in the diatom data between the typology categories vs. in the whole data.

	alpine vs. inland	inland vs. coastal	small vs. large	large vs. very large	clearwater vs. brown
A	0.031	0.005	0.015	0.004	0.014
p	<0.001	0.204	0.028	0.376	0.019

After evaluating the factors separately, the different typologies were tested for the combined factors, i.e. the grouping of the reference sites in the DCA ordination. Eigen value for the first ordination axis is 0.345, and for the second axis 0.216. The length of the ordination axis 1 is 2.317, indicating mostly unimodal responses of the diatom taxa, and so the suitability of the DCA for ordinating the data.

Ordination of the diatom taxa in the reference sites is presented in Fig. 6. The ordination of the species using only reference samples is similar to the ordination with 49 samples (Fig. 4), indicating that the first ordination axis represents decreasing trophy and humic substances in the water from left to right.

Ordination plot, with sites marked according to the Swedish typology is presented in Fig. 7, Finnish typology in Fig. 8, original TRIWA1 typology in Fig. 9, and revised TRIWA2 typology in Fig. 10.

The four tested river typologies are similar, with only minor differences in the defining factors. The degree of dystrophy (amount of humic material) is well reflected in the diatom composition. The proposed national typology for Sweden has the disadvantage that the use of 50 mg Pt l^{-1} water colour as the boundary is dependent on the annual and seasonal variation in the water colour. In 2006, the water colour was generally lower than usual in the area. The limit of 25 % peatland in the catchment area, as used by the Finnish system, appears too high; the 20% limit, used by the TRIWA typologies, is better in grouping the sites in this dataset.

The catchment size factor has relatively small effect on the diatom communities. The Finnish national typology has four catchment size categories, which appears unnecessary according to the diatom data. The use of only two ecoregions (above and below the conifer treeline) appears sufficient for the periphyton, since the historical coastline did not form distinct grouping of the sites.

Based on the results, the revised TRIWA2 typology is best suited for interpreting the diatom composition. However, the result is somewhat dependent on the dataset available; catchment size usually is a factor influencing diatom communities (because nutrient levels tend to increase downstream), but the other factors can mask the influence of the catchment size.

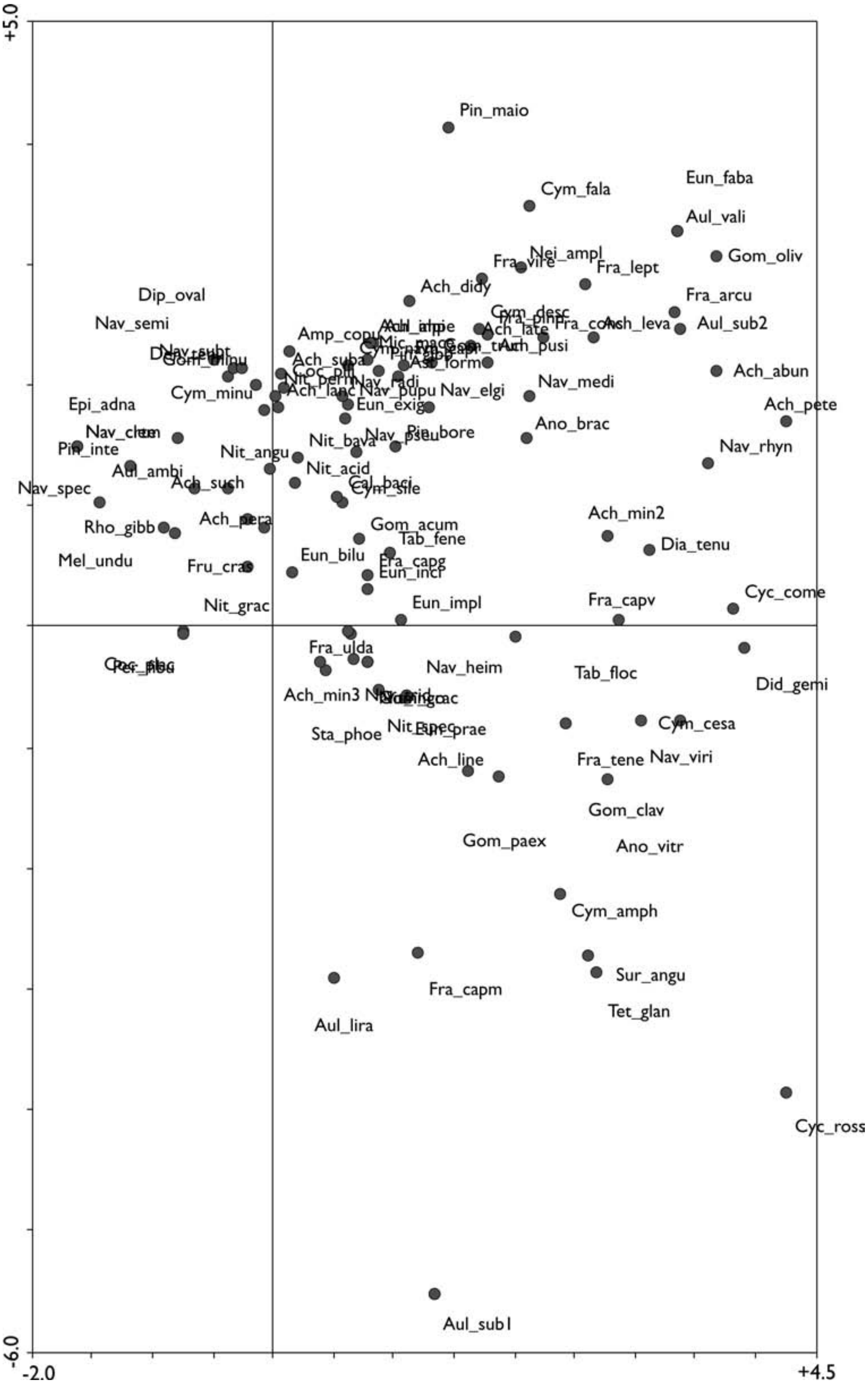


Fig. 6. DCA ordination of the diatom taxa in the 30 reference sites. Genus names are presented by first three letters, and species names by four letters, except when subspecies are identified they are presented by the last letter of the abbreviation.

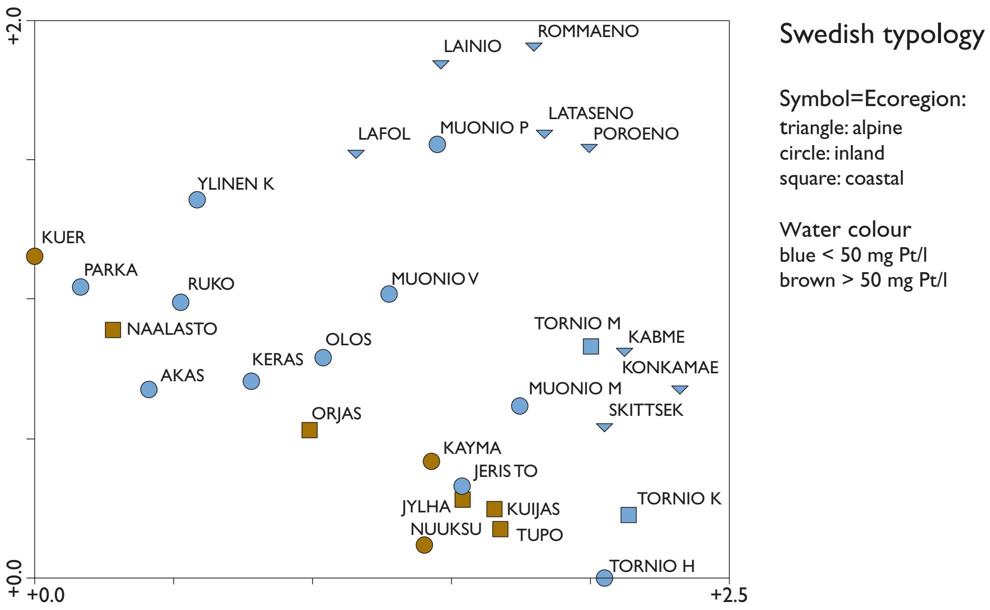


Fig. 7. DCA ordination for the 30 studied sites (except Kangosjoki site not plotted here), symbolized using the proposed Swedish national river typology.

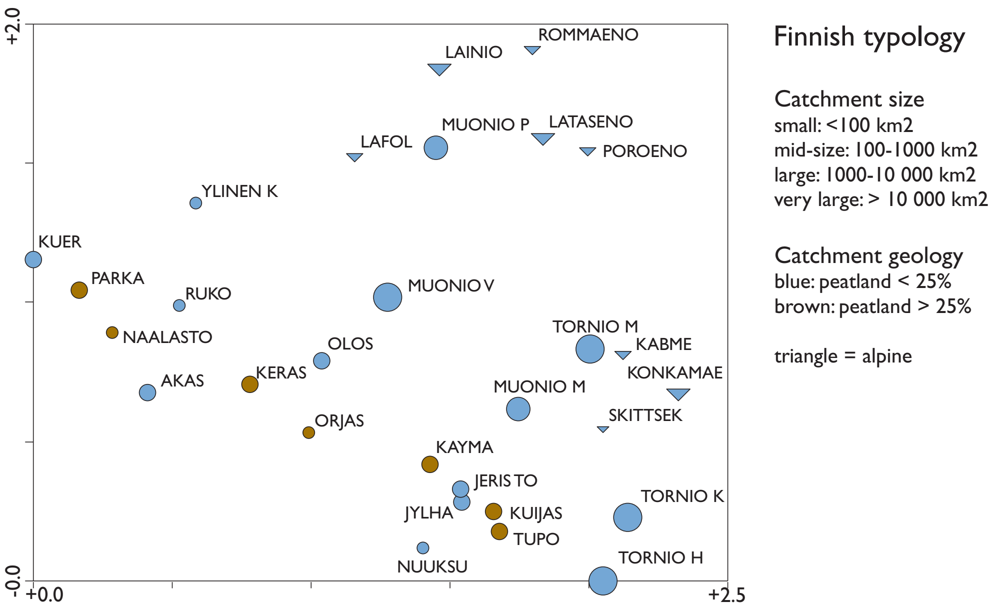


Fig. 8. DCA ordination for the 30 studied sites, symbolized using the Finnish national river typology.

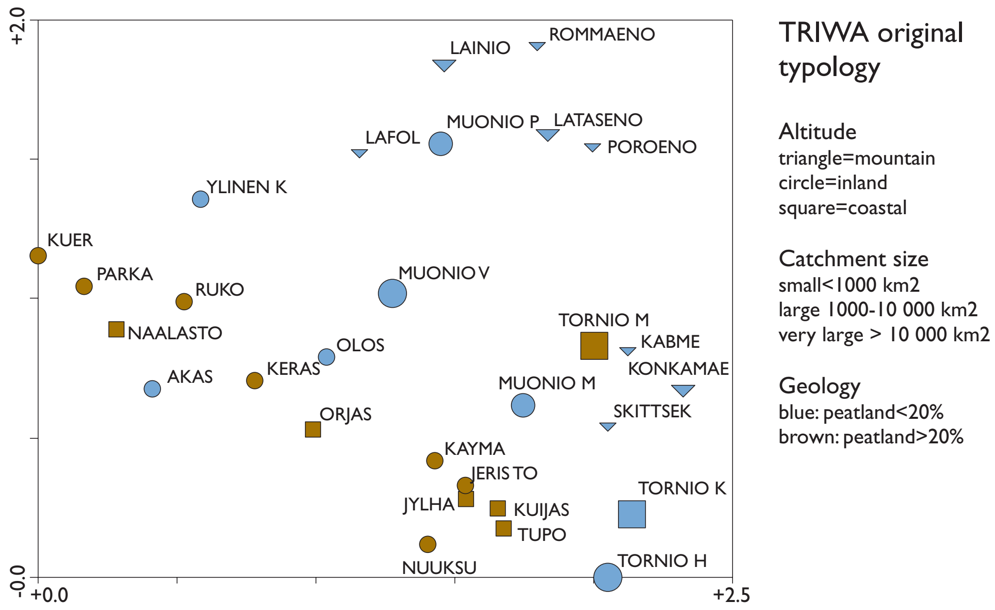


Fig. 9. DCA ordination for the 30 studied sites, symbolized using the TRIWA1 river typology.

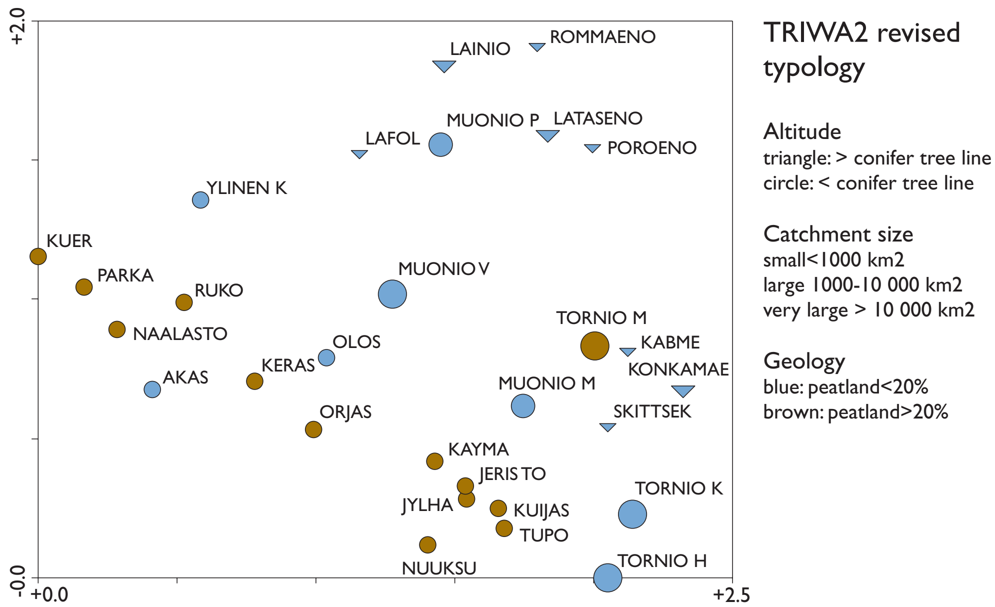


Fig. 10. DCA ordination for the 30 studied sites, symbolized using the revised TRIWA2 river typology.

3.4

Reference conditions

The low number of reference sites within the types (0–5 sites in each), except in type 4 (13 sites), limits the interpretation of the type-specific reference conditions. The reference conditions must be defined using the same metric that will be used for the ecological classification of the impacted sites, to enable the calculation of the Ecological Quality Ratios. As the metric for the ecological classification will probably be IPS, the reference conditions are here defined in the means of IPS values.

The 25^{th} percentile value of the reference IPS values for type 3 is the lowest of all types, 16.4 (N=3). The low 25^{th} percentile value is caused by the Äkäsjoki site, possibly affected by construction works in Äkäslompolo. For the brown water (organic geology) type 4, the 25^{th} percentile value is 16.5 and median value is 17.9 (N=13).

Reference value independent of the river type, i.e. the median value for IPS in all the reference sites (N=30) is 18.2. Since some minor anthropogenic impacts are found in the reference data (see Table 1), the 25^{th} percentile value for IPS in the reference data, 17.7, can be set as the lower limit of IPS indicating high ecological status. The 25^{th} percentile value for the reference data (N=30) is close to the Swedish national high/good status boundary (17.5). With this dataset, type-specific reference conditions can be set only for the type 4 (median IPS value = 17.9; N=13).

Table 5. Statistics of the IPS values in reference sites of the different river types.

	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7
25^{th} PERC.	17.65	18.10	16.40	16.50	18.00	-	17.98
MEDIAN	18.80	18.70	17.70	17.90	18.20	-	18.80
MIN	17.10	18.10	16.40	15.70	18.00	-	17.70
MAX	19.10	18.70	17.90	19.10	18.40	-	19.50
N samples	5	3	3	13	2	0	4

3.5

Ecological status

Results for the IPS indicate high status for most of the sites (Table 6). In Table 6, the ecological status classification is derived from the IPS according the status limits proposed in Finland (Eloranta & Soininen, 2002) and in Sweden (Kahlert *et al.* 2006). The status limits are in Finland/Sweden: high 17/17.5, good 15/14.5, moderate 12/11, poor 9/8, bad < 9/<8.

The results for the GDI and TDI indices are not treated further, because these indices proved to be not applicable for the data (see chapter *Testing the diatom indices*).

Of the reference data set of 30 sites, 5 sites received only good status. These sites are Kangosjoki, Kuerjoki, Parkajoki, Rukojoki, and Äkäsjoki. Of all sites, Juojoki received the lowest IPS value, indicating poor status. The other sites below good status are Kaartijoki and Naamijoki 290 (below fish farm).

The IPS values for the sites in the River Muonio and the River Torne all indicate high status, except good for Torne Pello according to the Swedish limits. However, the value declines downstream, from the Muonio Törmäsniva site (18.9) to Pello (17.1). The upper reach of the River Torne at Huhtanen and Kassa sites receives values comparable to the Muonio Markkina and Törmäsniva sites, 18.8 and 19.5, respectively.

The tributaries received more variable IPS values than the River Muonio and the River Torne, as expected from the more variable land use pressures.

Table 6. Diatom index values IPS, GDI and TDI for the studied sites. Ecological status according to the status limits for IPS proposed in Finland and in Sweden.

site	IPS	GDI	TDI	Ref. site	class FIN	class SWE
Jerisjoki 1	17.9	14.3	11.5		high	high
Jerisjoki Toras-Sieppi	18.2	13.7	12.9	R	high	high
Juojoki	11.9	12.1	9.5		poor	moderate
Jylhäjoki	19.1	15.9	14.8	R	high	high
Kaartijoki	12.2	12.7	13.3		moderate	moderate
Kangosjoki	15.7	13.4	11.2	R	good	good
Kannusjoki	19.4	16.4	15.7		high	high
Keräsjoki	17.9	16.9	17.5	R	high	high
Kuerjoki	16.4	14.7	15.9	R	good	good
Kuijasjoki	18.8	15.2	12.8	R	high	high
Kuittasjoki	17.9	17.0	14.5		high	high
Kåbmejåkka	18.9	15.4	14.8	R	high	high
Käymäjoki	18.5	16.1	14.2	R	high	high
Könkämäeno Pättikä	18.1	15.1	12.9	R	high	high
Lafoljåkka/Lainio	17.1	13.3	12.5	R	high	good
Lainio Jårkastaka	18.7	16.2	14.8	R	high	high
Liakanjoki	17.4	14.8	12.7		high	good
Liviöjoki	17.5	16.0	14.6		high	high
Lätäseno	18.7	15.4	13.3	R	high	high
Martimojoki	15.4	13.2	12.3		good	good
Matojoki	15.4	14.6	14.0		good	good
Mertajoki	18.0	16.2	11.6		high	high
Muonio Markkina	18.4	16.0	14.3	R	high	high
Muonio Palojoensuu	18.0	15.9	14.3	R	high	high
Muonio Törmäsniva	18.9	15.5	13.7		high	high
Muonio Vanha-Kihlanki	17.7	13.7	14.0	R	high	high
Naalastojoki	17.7	14.7	14.9	R	high	high
Naamijoki 290	13.0	14.1	10.9		moderate	moderate
Naamijoki K2	15.1	14.5	13.5		good	good
Nuuksujoki	18.4	13.2	11.4	R	high	high
Olosjoki	17.9	13.1	13.8	R	high	high
Orjasjoki	17.8	14.2	14.2	R	high	high
Parkajoki	16.4	15.7	16.8	R	good	good
Poroeno	19.1	15.3	14.5	R	high	high
Puruoja	16.8	12.8	10.2		good	good
Rommaeno	18.2	15.3	13.6	R	high	high
Rukojoki	16.6	11.8	13.2	R	good	good
Skittsekallojåkka	18.8	17.0	14.7	R	high	high
Tengeliönjoki 240	17.3	15.0	12.2		high	good
Tengeliönjoki Portimo	18.9	15.0	12.5		high	high
Torne Huhtanen	18.8	16.7	14.6	R	high	high
Torne Kassa	19.5	16.1	14.3	R	high	high
Torne Kukkola	17.5	13.7	13.2		high	high
Torne Matkakoski	18.8	14.3	9.9	R	high	high
Torne Pello	17.1	14.8	13.3		high	good
Tupojoki	18.4	14.7	12.6	R	high	high
Ylinen Kihlankijoki	17.7	13.9	12.7	R	high	high
Ylinenjoki	19.3	13.8	14.0		high	high
Äkäsjoki	16.4	12.9	12.4	R	good	good

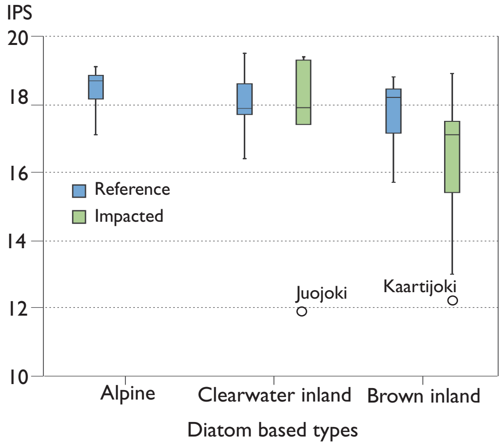


Fig. 11. Distribution of IPS values in reference and impacted rivers in the alpine, clearwater inland, and dystrophic river types.

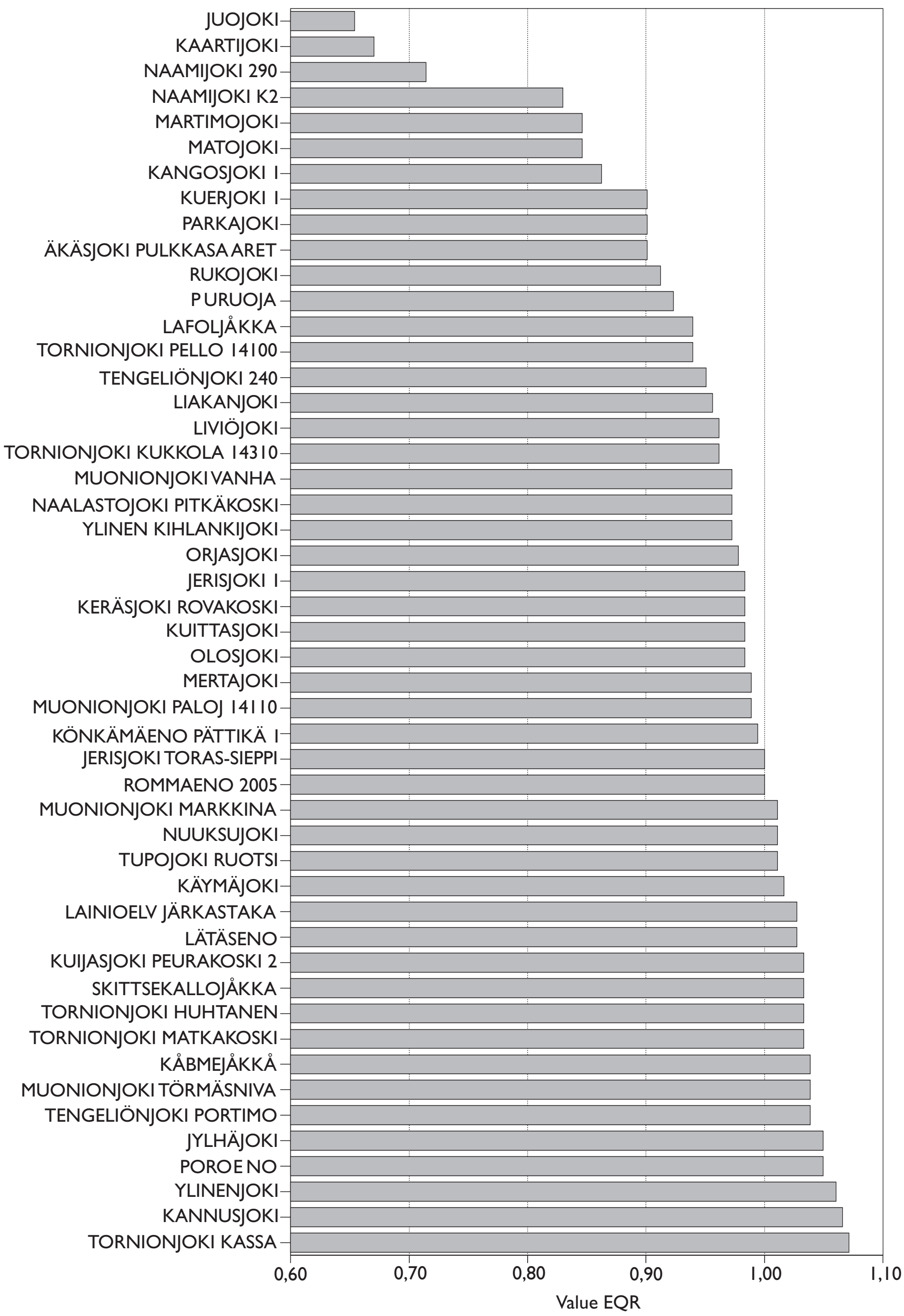


Fig. 12. Ecological Quality Ratios (EQRs) for the studied 49 sites, based on the IPS values.

Based on the data, different ecological status class boundaries for IPS could be set for three groups of river types: alpine (> conifer tree line), clearwater inland (peatland < 20%), dystrophic inland (peatland > 20%) (Fig. 11). The TRIWA2 types 1 and 2 form the alpine rivers, types 3, 5 and 7 the clearwater inland rivers, and types 4 and 6 the dystrophic rivers.

The small inland sites have all more than 10 % of peatland in their catchment area, separating them from the alpine sites with inorganic geology. If only these three types are used, the reference conditions (high ecological status) could be defined as IPS > 18 for alpine type, IPS > 17.5 for clearwater type, and IPS > 17 for brown water type.

The Ecological Quality Ratios (EQRs) for the sites (Fig. 12) are calculated as the observed/predicted IPS value. The predicted value is the median of the reference data in each type. The minimum EQR value in the dataset is received by Juojoki (IPS=11.9, EQR=0.650).

The Finnish and Swedish class limits for the IPS result in the same three sites receiving lower than good status: Juojoki, Kaartijoki and Naamijoki 290. The reference data of 30 sites would suggest the use of the higher Swedish IPS limit for high ecological status in the River Torne area: the 25th percentile of the reference sites, 17.7, is close to the Swedish high status boundary. The project was mainly aiming at reference areas, thus the data is weighted towards them, and a reliable assessment of the lower status boundaries is not possible with this dataset.

3.6
Ecological groups of diatoms

The proportion of the diatoms in different saproby and nitrogen uptake classes according to Van Dam *et al*. (1994) supports the IPS results. The scale of the saproby classification of Van Dam *et al.* (1994) is not fully relevant in the northern conditions, where the scale of trophy levels is much lower than in the Netherlands, where the classifications are made. For example, Van Dam et al. (1994) classify an abundant species, Tabellaria flocculosa, as beta-mesosaprobic, although in nordic rivers it thrives in clean, (ultra)oligotrophic conditions.

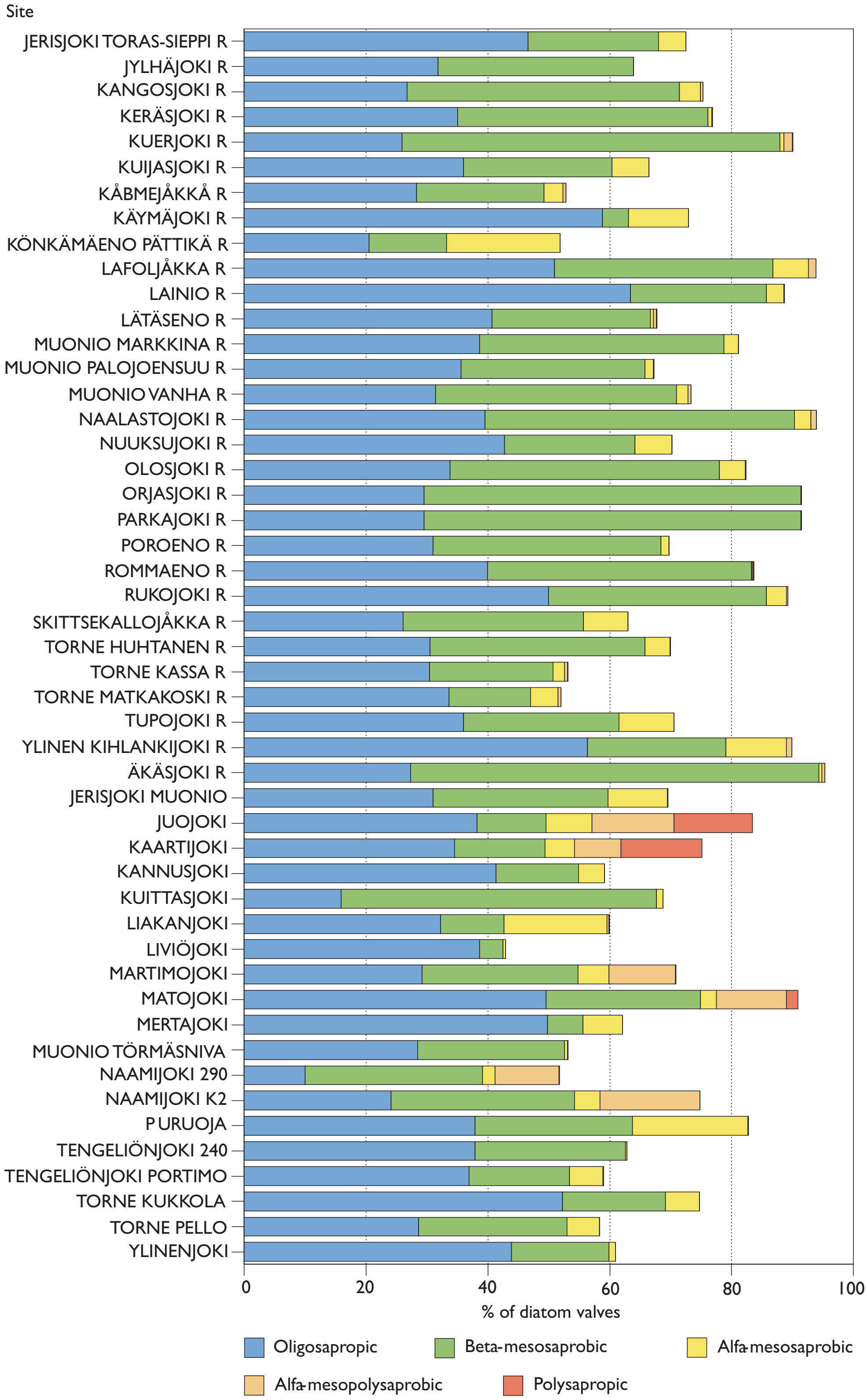


Fig. 13. Saprobic classification of the diatoms in the studied samples according to Van Dam *et al.* (1994). Reference samples are marked by R.

Saprobic classifications clearly indicate the dominance of primarily autotrophic diatoms, expected in conditions of low levels of organic loading in the rivers (Fig. 13). Samples from Juojoki and Kaartijoki include significant proportion of diatoms indicating polysaprobic and alfa-mesosaprobic conditions. Also the rivers Martimojoki, Matojoki and Naamijoki contain large proportions of alfa-mesosaprobic diatoms.

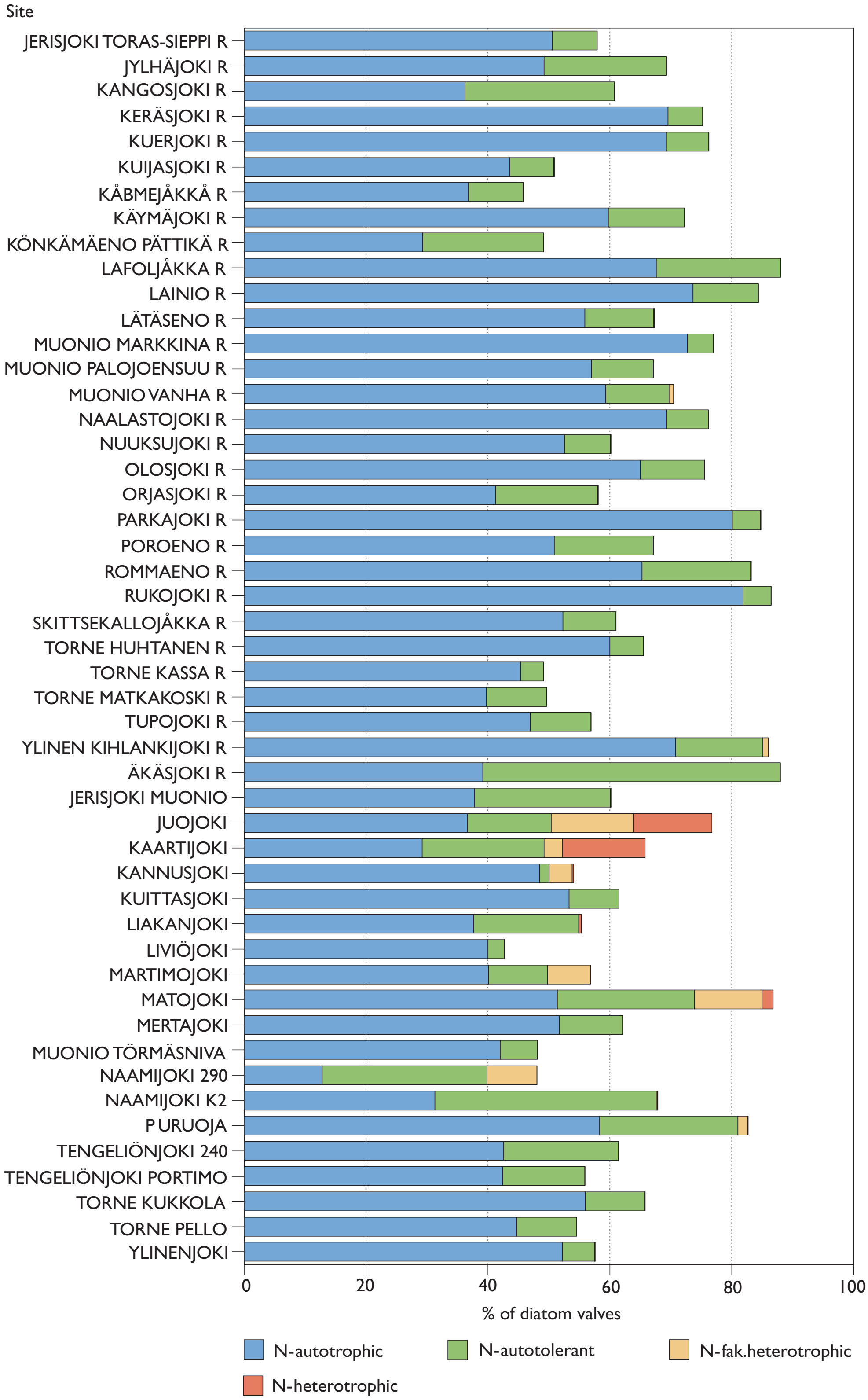


Fig. 14. Classification of the nitrogen uptake metabolism of the diatoms in the studied samples according to Van Dam *et al.* (1994). Reference samples are marked by R.

Nitrogen uptake metabolism indicates primarily N-autotrophy in most of samples (Fig. 14). Organic N-compounds appear available in the same rivers where saprobic level is also high, supporting the results of the saprobic classification.

Diatoms indicating polysaproby or obligatory N-heterotrophy are not found in the reference samples. Also higher percentage of the diatoms can be classified for the reference samples; the proportion of unclassified diatoms is over 50 % for some impacted sites.

4. Discussion

The summer 2006 was very dry and during the sampling period the water levels were low, especially in the southern part of the watershed. This appears to have some effect on the water quality of the rivers. The nutrients and total organic carbon levels were lower than normal in the rivers: mean total P concentration in the Finnish national monitoring sites in the area (N=10) has been 10 µg l^{-1} during the period of 2000–2005, whereas in 2006 it was 8 µg l^{-1}. Mean water colour value was 45 mg Pt l^{-1} for the same sites in 2000–2005, whereas in 2006 it was 30 mg Pt l^{-1} (unpublished data, database of the Ministry of the Environment).

Niemelä *et al*. (2002) studied nine sites in the rivers Muonio and Torne common with this study in 2001 for diatoms and water quality. Total P concentrations and water colour were systematically lower in 2001 than in 2006. However, lower IPS values were calculated in this study than Niemelä et al. (2002). Updates to the indicator values of some taxa in IPS index may account for at least some of the difference in the results.

Water quality monitoring data on eight of the small tributaries (unpublished data, compiled by Patrik Olofsson, County Administrative Board of Norrbotten) indicates for all the rivers that water colour and total organic carbon concentrations have been lower than earlier in summer 2006, and free cations (Mg, K, Ca) levels higher. Ylinen Kihlankijoki site is the most frequently monitored of these sites (Fig. 15, 16).

The use of peatland percentage of the whole catchment area, for inference on a particular site may be problematic, many times not correctly representing the organic load at the site. The peatland percentage is not very strongly connected to the water colour in the dataset (Fig. 17). This may be the main reason for mixing of some of the clearwater and brown water sites in the ordinations. All the inland sites in small catchments (>1000 km^2) have organic geology in some parts of their catchments (> 10 % peatland). The distance of the peatlands from the sampling sites is probably an important factor affecting the water quality.

IPS was found sensitive for the pressures existing in the studied area, which is the most important criteria for a good metric for the ecological classification. IPS is not too dependent on the typology factors, so that the influence of the varying natural conditions is not mixed with the human impacts.

When the IPS values were compared with the ecological classification of Van Dam *et al.* (1994) for the sites with intense water colour, the IPS values were found consistent with the ecological classifications for most of the cases. Only sites Martimojoki and Matojoki received good status regardless of the elevated levels of saproby in the diatoms, significant human pressures and deteriorated water quality. The IPS value 15.4 for both of the sites is however close to the moderate status, and they could be classified as moderate when the growing amount of data is utilized for the setting of the ecological status limits in the region.

The good/moderate and lower status boundaries cannot be reliably assessed by the available data, because too few sites represent conditions below good status. Based on the data, the higher Finnish limits for good, moderate, and poor status are more suitable in the River Torne area, than the Swedish limits. More data is needed on the impacted conditions, for adjusting the limits according to the natural conditions in the area. The IPS limit for the good ecological status may be adjusted to 15.5 or 16 in the future, if more data will support this. After all, clearly impacted sites such as Martimojoki and Matojoki receive IPS value of 15.4.

Fig. 15. Total organic carbon (TOC) concentrations (mg l^{-1}) in Ylinen Kihlankijoki site 1995–2006 (mean values in August). Figure by Patrik Olofsson.

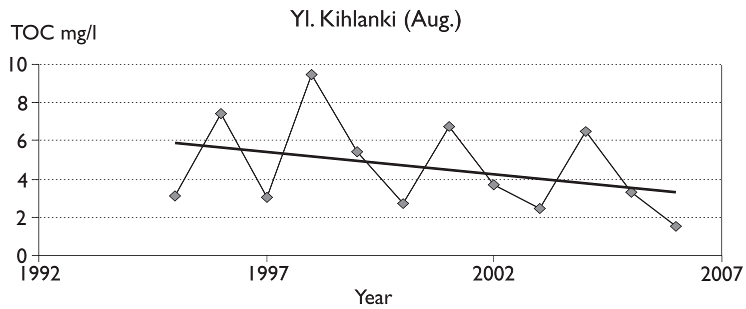
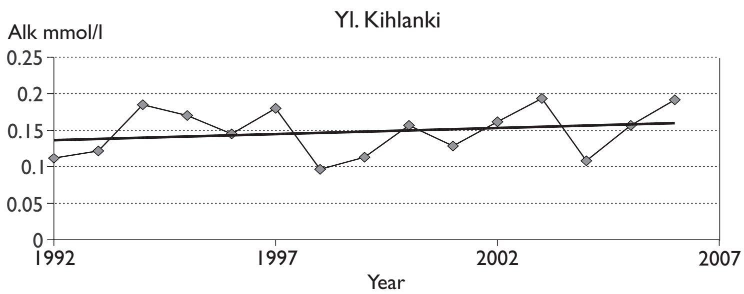


Fig. 16. Alkalinity (mmol l^{-1}) in Ylinen Kihlankijoki site from 1992–2006 (mean values in August). Figure by Patrik Olofsson.



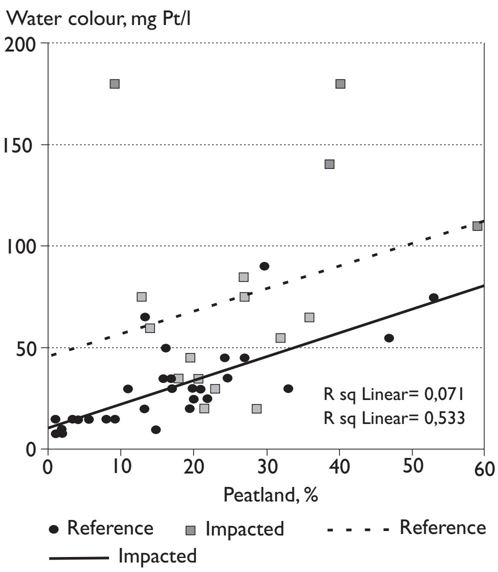


Fig. 17. Relation between the peatland percentage in the catchment area and water colour (mg Pt l^{-1}) at the studied river sites, separately for reference and impacted site data.

5. Conclusions

Total of 171 diatom taxa were identified in the 49 sites. Number of taxa in one site varied from 18 to 43. The most common and abundant diatom taxa in the rivers in reference conditions are *Achnanthes minutissima* (thin varieties), *A. pusilla, Eunotia implicata, Fragilaria capucina* var. *gracilis, F. ulna* var. *danica*, and *Tabellaria flocculosa. Cymbella falaisensis* was found common species in the alpine, mountain rivers.

Diatom communities in the River Torne catchment area are different in alpine and inland conditions, when conifer tree line is the limit. Inland vs. coastal communities could not be differentiated, i.e. highest historical coastline was not found to be an important factor. Headwater rivers in small watersheds (< 1000 km^2) have more variable water quality and diatom communities than larger rivers downstream. Catchment geology is an important factor, but setting of the category limit(s) is problematic; organic vs. inorganic geology is also reflected in the alpine vs. inland grouping of the diatom communities.

Based on the analyses of the 49 site dataset, the revised TRIWA2 typology with seven river types is recommended as a simple and working typology. Possibly three different status class limits for phytobenthos could be used in the future: for alpine, clearwater and brown water river types.

Of the tested diatom indices (IPS, GDI, TDI), only IPS fulfilled the criteria for a good metric for ecological classification – detection of impacts and consistent (linear) relationship with the pressures. IPS was used for assessing the ecological status of the studied 49 sites in the River Torne watershed. According to the reference site data, the IPS limit for high ecological status in Swedish system (17.5–20) is suitable for the River Torne watershed.

Multivariate analysis clearly shows that ecoregion (alpine vs. forested) and geology (amount of peatland) have strong effect on the diatom communities. However, the IPS index is much less affected by these typology factors than the human pressures, suggesting that the same metric can be used for all the river types in the area for ecological classification.

More sites should be analysed in the future for fine adjustment of the reference conditions and ecological status classes, and to make specific pressure-response analysis for the IPS and other possible metrics. More data is needed especially on the reference conditions for river types 3 and 6, and impacted conditions generally. Data from other studies done in Lapland could be used for filling the gaps in the data.

In the future, monitoring the rivers where large-scale soil ditching and peat mining occur is important. In addition, the sites that received values of diatom index IPS below 15 or close (i.e. the rivers Juojoki, Kaartijoki, Matojoki, Martimojoki and Naamijoki) should be monitored for the development of their ecological status.

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Part III

Final conclusions and recommendations

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1. Conclusions

Direct cooperation in water management has this far been realized mostly between authorities and research organizations according to their subject area and mandates. In the Torne River area, the delayed renewal of the Frontier Rivers Agreement has lead to a situation where harmonization needed for the practical work has been made in very close contact between LAPREC and CAN with input from expert organisations like FGFRI, SYKE, Swedish Board of Fisheries etc. Resources for this work have been dependent mainly on project funding. Many obstacles, partially defined also during this project, have slowed down and even hindered the process such as delayed international and national guidance and criteria, dissimilarities in schedules etc.

The legislation and practices for permit procedures and administrational decisions influencing water issues are not strikingly different in Finland and Sweden, thus no overwhelming obstacles are found in this area. Further demands set under EU umbrella probably tune legislations even closer to each other – on the other hand different interpretation and implementation of EU directives can lead the opposite way, too. Even when differences exist, it can be concluded that the objectives are similar even though instruments or practices differ. However, in processes not covered here, there can be more incongruities. Differences seem to be more apparent in actual implementation of WFD, and even there the basic structure does not set major obstacles. Tuning the system for an IRBD is still needed. Whether the renewal of the Frontier Rivers Agreement is still delayed or not, mutual steps towards further harmonization are needed.

The aspects in water management are so wide and influence so many parts of everyday work that in this project it has been possible only to scratch the surface of some parts of them. As the national guidance for many issues is still incomplete, there will be new questions arising due to that. In addition, new directives and agreements, for example the Flood Directive (2007/60/EC) that entered into force in December 2007, set new demands for harmonization. It can be argued that in national implementation of the directives and agreements, already in early stages of the process, the needs in IRBDs should be taken into consideration, and needed harmonization discussed and agreed on with the states in question.

The need for harmonization is both in management issues and in ecological issues. Even though there has been international intercalibration processes going on, the testing and comparisons made in TRIWA projects reveal that the work has only started. It is obvious that continuing the work is necessary and inevitable.

In addition, despite the already well developed participatory processes in both Finland and Sweden, it is clear that special attention has to be paid to developing this area, especially in local context. This demands genuine effort from all involved. Current resources, especially on Finnish side, are barely sufficient for the traditional participation, and additional resources are badly needed, especially due to the vast geographical area of the IRBD.

In the following parts, suggestion for the cooperational structure for the Torne River IRBD is presented, together with a diagrammatic time table for the work, and finally suggestions and recommendations for future work.

2. Suggestion for the structure of cooperation

The structure for cooperation presented here is suggested as a basis for further development. It is always good to remember that the true cooperation is interaction between people and structures defined are, at their best, only supporting this interaction. In addition, new tasks (for example those deriving from Flood Directive) can set demands for further revising and additional issues to be taken into account.

The harmonizing and decisive body for the area would be FRC after the revised agreement - or some other formal or informal joint body if the revising is delayed (Fig. 1). It is recommended that a work group be established to support and to prepare the decisive body's work. In addition, a separate expert group is advisable, the group concentrating on harmonizing the typology and classification criteria and working on other issues involved within these subjects.

The work group could have members from Lapland Regional Environment Centre, County Administration of Lapland, County Administrative Board of Norrbotten and representatives of municipalities etc. Major lines and issues are presented to the Water Parliament (see further) in annual meetings. Representatives of Parliament could be part of the actual work group if desired. Norwegians could participate as full members or be closely informed of the issues depending on their needs.

Expert group could have members from specific fields depending on the issue, with flexible combination (fishery, aquatic ecology etc.) from both Finnish and Swedish parts, Norwegians again according to their needs, regional experts as well as members of national responsible organs and, again when needed, other experts (universities, research organisations, independent experts etc.).

Water Parliament (WP) would be the regional reference group/joint working group – 'water board', with open participation. The Parliament would work as a discussion forum in water management issues. Meetings could be arranged annually or biannually. It is important, that WP would be open for all interested parties, as the wider the base for participation is, the better the different views in the region can be discussed. Consensus reached within WP would give strength for the regional views. There could be a separate WP work group, appointed by the WP, working more closely with the authorities responsible for the implementation of the water management processes, or perhaps participating in the work group under the decisive body. Secretary for the WP, taking care of the practical arrangements, could technically be working under any regional authority, municipality or organization accepted by the WP.

Local groups could organize freely. Here the activity of the people is important as the form of participation can differ widely. It would be good to have resources to support the local work – perhaps applying funding through Frontier River Commission or some other source.

A suggestion for a diagrammatic schedule for the water management work following WFD steps is presented in Fig. 2. The public hearing/consultation period is harmonized according to the public hearing period defined in Finland. Without harmonization, the earlier period has to be the pacemaker. Needed time for final translations and printing procedure (layout and printing) are taken into account – in the Torne River area at least three languages are to be used (Swedish, Finnish and North Lappish.

This schedule does not include suggestions for timing the expert work nor local work. Expert work, giving support to the actual ecological evaluations is and will be one of the continuous tasks. The work group can define the needed timetable according to its needs.

Participation of the experts of national implementing agencies of water management and representatives of the responsible ministries is considered beneficial both for River Torne and for national cooperation in water management. It is therefore recommended that local administrative cooperation is enforced by national experts and / or ministry representatives for establishing water management cooperation of national significance in River Torne. This is needed for ensuring that national guidelines are in harmony in local implementation and for timely decision making. Testing national water management guidelines and interpreting water management legislation in practise could be the activities for such cooperation.

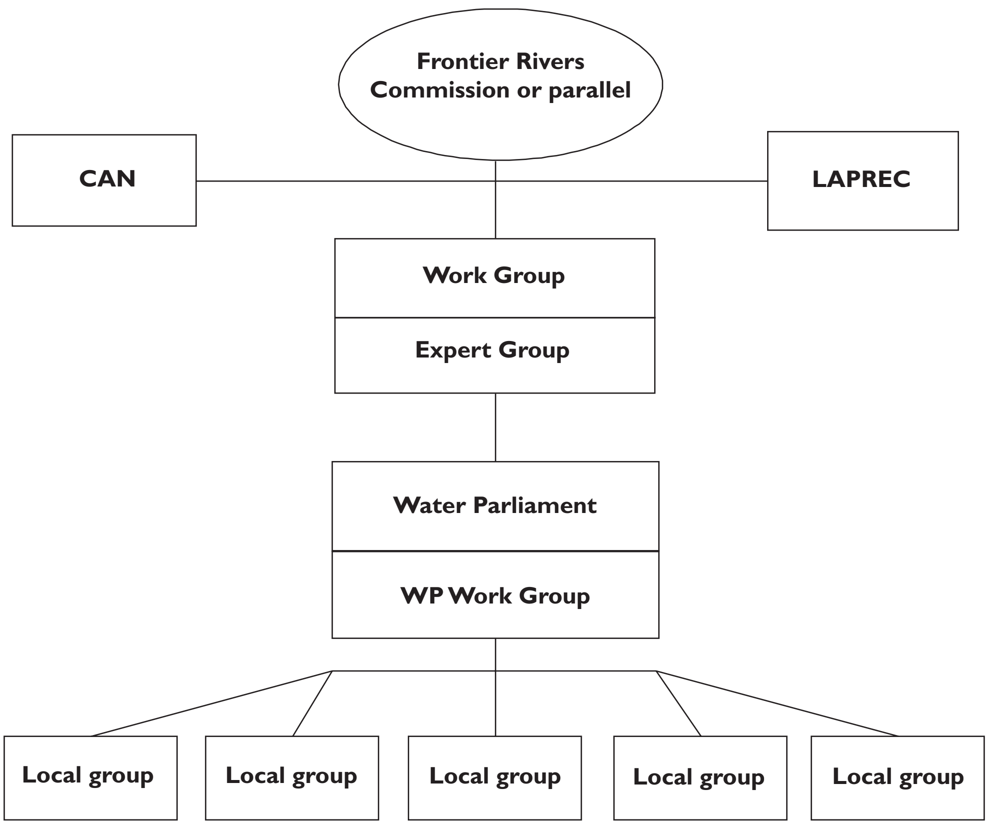

Fig 1. Suggested structure for the cooperation in water management in Torne River area.

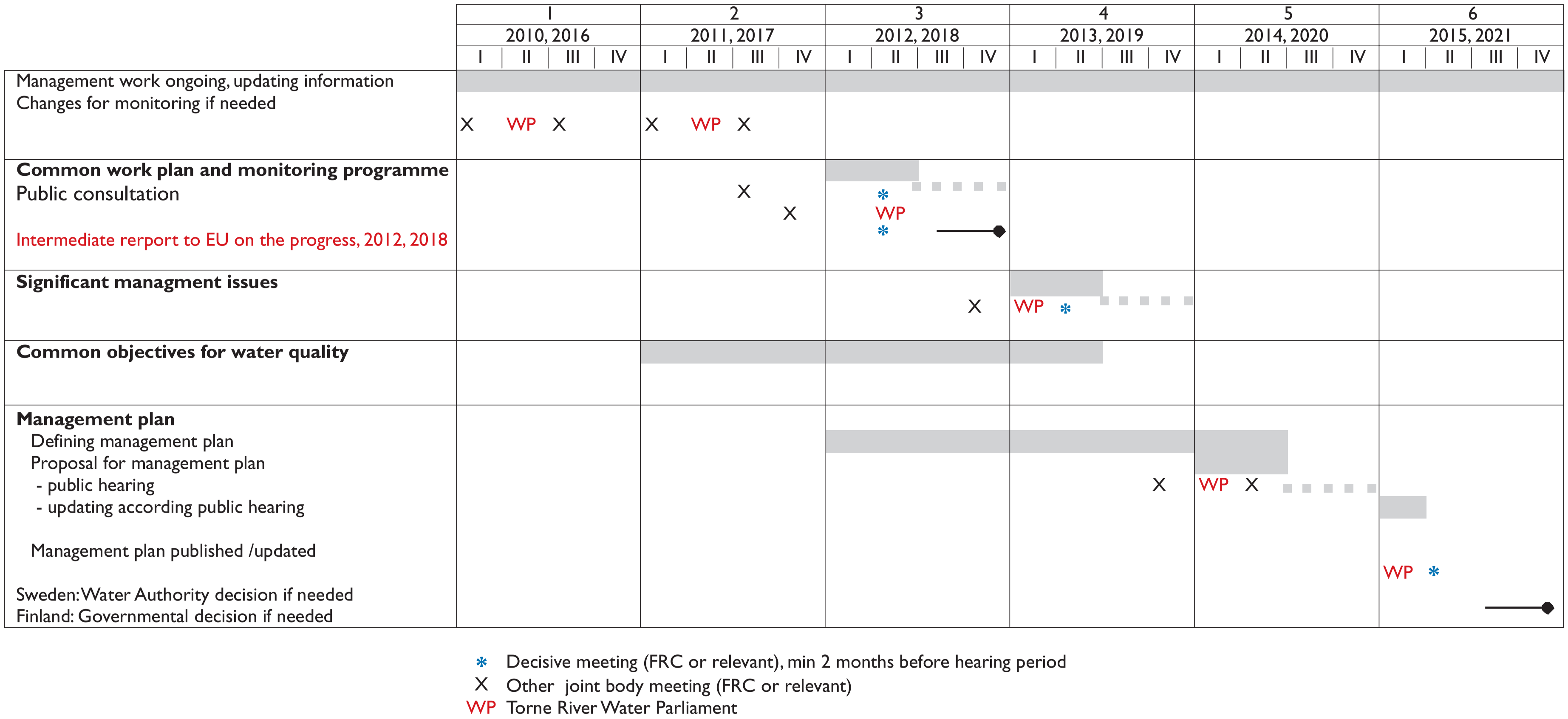

Fig 2. Adjusted timetable for the water management cycle in Torne River area.

3. Recommendations and suggestions for the future

In different chapters of this report, numerous, partially detailed recommendations and suggestions are given for the future work in Torne River IRBD. Many of the issues are common for many IRBDs, depending on how far the harmonization work between the states involved has gone. Below, major suggestions are summarized. Priority I and II are marked separately.

Administrative decisions or changes in national legislation are needed for example in following issues:

Prior I.
- Harmonization of the public hearing/consulting periods
- Acceptance of using harmonized evaluation methods in an international RBD, including typology, classification and methodology.

Prior. II.
- Separating the Torne River part from the Bothnian Bay water district in Sweden

A work group is appointed for the area with sufficient resources to handle the practical work. The most important issue for the group is to prepare harmonized management plan, especially the suggestions for the objectives of the common water basins and the measures needed to gain the objectives. This field is practically unexplored.

An expert group is named for accepting common criteria (typology, classification) for the area. The minimum level is naturally criteria for the common water bodies (here frontier rivers and lakes), but finally they are to be harmonized for the whole river basin district. The decisions are based on scientific data and regional knowledge. Further, the group can work on the numerous issues needing expert judgments for preparing guidelines. In addition, it is suggested that **workshops or equivalent meetings** with wider participation are arranged. In these, expert organizations have a core role.

Prior II. Participatory processes, especially for the cross border work in the region are further developed

- Resources for creating possibilities and activating participatory processes are reserved for the region, including authorities, NGO's etc., for example following issues:
  - the Water Parliament is developed into a more permanent co operational body in the region.
  - local meetings are used actively in needed issues
  - arranging local work is supported
  - internet tools are developed and taken in active use for participatory work.

Finally, it is suggested that the work started in TRIWA projects is continued also in the ecological field. This vast, complex area is hardly explored, and the lack of knowledge is apparent. Many of the indices and methods used are tested in other circumstances, and this can lead to biased interpretation of the environmental status in this northern environment.

DOCUMENTATION PAGE

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Author(s)	Luokkanen Eira, Olofsson Patrik, Hokka Ville and Sundström Bo (eds.)			
Title of publication	**TRIWA II Management of an International River Basin District – Torne River**			
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Theme of publication	Environmental protection			
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Abstract	In TRIWA II project, realized in 2006-2008, practices for the management of the Torne River, an international river basin district, were developed. For this, environmental legislation and administration in Finland and Sweden were compared and possible obstacles were charted. This included framing participation processes in water management. In addition, ecological issues were included in the project, as they form the basis for evaluating the status of the environment. The legislation and administrative systems in Finland and Sweden are very similar. There are no major differences, but in some issues, for example in forest drainage or construction in or close to the shore area, the procedures and legislation have somewhat different approach. On the other hand, in water management, the interpretation and implementation of the common Water Framework Directive have differences that influence the cooperation across the border. For example, the schedule for public hearings that pace the administrational work in addition to the directive is different in these neighbor states. People's opinion on and wishes for cooperation across border were surveyed. Even though the public participation systems are well developed both in Finland and Sweden, people feel that they are not necessarily heard in water management issues, or that their opinions are not taken into account in decision making. There is a genuine wish and need for cooperation across the border in Torne River area. Especially informal participatory processes need developing. A co operational structure for the area is suggested. Earlier developed typologies for rivers and lakes of Torne River area were tested with fish (lakes) and phytobenthos (rivers). The results supported the typologies. Simultaneously, national classifications of the ecological status were tested. It became clear that harmonization of national indices is necessary, as the evaluation of the ecological state using fish analysis gave very different results depending on the system used. With phytobenthos, the results were very close to each other. It is obvious that the evaluation systems have to be tested and carefully chosen for the region. It also seems that the earlier suggestions for simplified typologies are usable in the area.			
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<tr><td>Tiivistelmä</td><td colspan="4">Vuosina 2006-2008 toteutetussa TRIWA II –hankkeessa kehitettiin vesienhoidon käytäntöjä Tornionjoen kansainvälisellä vesienhoitoalueella. Tätä varten Suomen ja Ruotsin ympäristölainsäädäntöä ja -hallintoa verrattiin toisiinsa ja tuotiin esille havaittuja ongelmakohtia. Lisäksi kehitettiin osallistumiskäytäntöjä. Myös ekologiset kysymykset sisältyivät projektiin, sillä ne muodostavat perustan ympäristön tilan arvioimisessa.
Lainsäädäntö ja hallintojärjestelmät ovat Suomessa ja Ruotsissa hyvin samankaltaisia. Erojakin on etenkin lähestymistavoissa. Esimerkiksi metsäojituksia ja rannanläheistä rakentamista tarkastellaan eri tavalla. Toisaalta vesienhoidossa vesipuitedirektiivin tulkinnassa ja toimeenpanossa on eroja, jotka vaikuttavat rajat ylittävään yhteistyöhön. Esimerkiksi julkisten kuulemisten aikataulu on erilainen Suomessa ja Ruotsissa. Yhteisen vesienhoidon käytännön edistämiseksi esitetään kehittämis- ja harmonisointikohteita.
Hankkeessa selvitettiin alueen asukkaiden ja toimijoiden mielipiteitä ja toiveita rajat ylittävästä yhteistyöstä. Vaikka Suomen ja Ruotsin osallistumiskäytännöt ovat hyvin kehittyneet, ihmiset kokevat, ettei heitä kuunnella vesistöjen hoitoon liittyvissä kysymyksissä, tai heidän mielipiteitään ei oteta huomioon päätöksenteossa. Tornionjoen alueella on selkeä tarve ja halu rajanylittävään yhteistyöhön. Erityisesti epämuodollisia osallistumistapoja kaivataan. Hankkeessa tehdään esitys yhteistyön järjestämisestä alueella.
Tornionjoen alueelle aikaisemmin kehitettyjä jokien ja järvien tyypittelyjärjestelmiä testattiin. Järvityypittelyä testattiin kalastotutkimuksien avulla ja jokityypittelyä päällyslevätutkimuksilla. Saadut tulokset tukivat näitä tyypittelyjä. Samanaikaisesti testattiin kansallisia luokitteluja, joilla arvioidaan vesistön tilaa. Kävi selväksi, että luokittelujen yhteensovittaminen on välttämätöntä, sillä kansalliset luokittelutavat antoivat erilaisen tuloksen esimerkiksi järvien ekologisesta tilasta kala-analyysien perusteella. Jokivertailussa käytettyjen päällyslevien osalta kansalliset raja-arvot vastasivat toisiaan melko hyvin. Onkin selvää, että arviointijärjestelmiä täytyy jatkossakin testata ja arvioida niiden soveltuvuutta alueelle. Näyttää myös siltä, että aikaisemmat ehdotukset yksinkertaistetusta järvien ja jokien tyypittelyistä sopisivat Tornionjoen alueelle.</td></tr>
<tr><td>Asiasanat</td><td colspan="4">Vesipolitiikan puitedirektiivi, vesienhoito, kansainvälinen vesienhoitoalue, osallistuminen, Tornionjoki</td></tr>
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PRESENTATIONSBLAD

Utgivare	Lapplands miljöcentral, Länsstyrelsen i Norrbottens län	*Datum* Februari 2008
Författare	Luokkanen Eira, Olofsson Patrik, Hokka Ville och Sundström Bo (förf.)	
Publikationens titel	**TRIWA II Förvaltning av ett internationellt vattendistrikt – Torne älv** (TRIWA II Management of an international river basin district – Torne River)	
Publikationsserie och nummer	Miljön i Finland 10/2008	
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Sammandrag	TRIWA II var ett samarbetsprojekt mellan finska Lapplands miljöcentral och Länsstyrelsen i Norrbotten tillsammans med Vilt- och fiskeriforskningsinstitut, Fiskeriverket och Finlands miljöcentral som pågick mellan åren 2006-2008. Inom projektet utvecklades metoder för gemensam förvaltning av Torne älv genom att miljölagstiftningen och administrationen i Finland och Sverige jämfördes och möjliga hinder kartlades. Även möjligheten att utöka allmänhetens deltagande inom vattenförvaltning främjades. Ekologiska frågeställningar var också en del av projektet eftersom dessa är basen för att utvärdera statusen i vattenmiljön. Lagstiftningen och de administrativa systemen i Finland och Sverige är väldigt lika. Det finns inga stora skillnader, men i vissa specifika ärenden, till exempel markavvattning inom skogsbruket eller strandnära byggande ser processerna och lagstiftningen något olika ut. Däremot har tolkningen och implementeringen av det gemensamma vattendirektivet lett till skillnader inom vattenförvaltningen vilket påverkar samarbetet över gränsen. Till exempel sker remisstiderna vid olika tidpunkter. Människors åsikter och önskan till samarbete över gränsen undersöktes. Ett behov att bygga vidare på detta framfördes. Även om möjligheten för folk att göra sin röst hörd är god i både Finland och Sverige känner människorna att deras åsikter inte nödvändigtvis beaktas när det gäller vattenförvaltningsfrågor eller vid beslutsfattande. Det finns en genuin önskan och ett behov att samarbeta över gränsen i Tornedalen. Speciellt den informella publika samrådsprocessen bör utvecklas. En gemensam samarbetsstruktur för området föreslås. Tidigare utvecklade sjö- och vattendragstyper inom Torneälvens avrinningsområde testades med hjälp av sjöfisken och påväxtalger i rinnande vatten. Resultaten stödjer typerna. Samtidigt testades också nationella klassificeringssystem gällande ekologisk status. Det framgick tydligt att harmonisering av de olika nationella indexen är nödvändigt eftersom den ekologiska statusen gav olika resultat när fisk i sjöar utvärderades. Gällande påväxtalger var resultaten väldigt nära varandra. Det är uppenbart att de olika klassificeringssystemen måste noga testas och väljas inom regionen. Det förefaller också vara så att de tidigare förslagen till en enklare typologi för sjöar och vattendrag är användbar inom området.	
Nyckelord	Ramdirektivet för vatten, vattenförvaltning, internationellt vattendistrikt, deltagande, Torne älv.	
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